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The Street Railway Convention. THE Pittsburgh convention of the American Street Railway Association, just closed, may be reckoned as one of the most successful in the history of the organization. The attendance was very large and the exhibits excellent, although unfortunately, owing to the lack of proper accommodations, they were somewhat scattered. The papers read at the convention—with the exception of two that were not electrical—are published in the current issue. They will be found to be of unusual interest to electricians, as they constitute a very creditable résumé of the present condition of electric traction in this country. It must be hard for the old-fashioned street railway man to realize the wholesale way in which the street railways of the country have adopted electricity as a motive power, and the rapidity with which the horse has been eliminated from street car service. The cable road is holding its own somewhat more effectively, although as time goes on fewer and fewer cable roads are likely to be installed, and undoubtedly some that are now operated by the cable system will pass over to the use of electricity. So thoroughly electrical was the character of the convention that the current issue of THE ELECTRICAL WORLD contains practically as full a report of the proceedings as we are in the habit of according to the conventions of the National Electric Light Association. In THE ELECTRICAL WORLD of Oct. 25, 1890, we published what we considered a very complete report of the electrical features of last year's Street Railway Convention, but we find we are compelled to devote more than twice as much space to our report of this year's meeting. The next convention will be held at Cleveland, O., and is likely to be of even greater importance electrically than the present one.

Standardizing Electric Railway Practice. THE thoughtful paper of Mr. O. T. Osbor on this subject, read at the Street Railway Convention, and published elsewhere in this issue, is worthy of very careful consideration on the part of electrical manufacturers. At present there is uniformity neither in the nomenclature nor in the dimensions of the various elements that go to make up an electric street railway system. In the rating of street railway motors especially there are wide differences of practice. Inasmuch as such a machine is never put to uniform service, and no two machines of the same maker are likely to be treated exactly alike, there may naturally be honest differences of opinion as to what shall be called, for example, a 15-h. p. motor, the size generally employed at present. Many motors so rated will stand working up to 30 h. p. for a considerable time without breaking down, although under such circumstances their efficiency is somewhat low. Obviously the tendency is for the manufacturer to put a rather high rating on his machine out of commercial policy, while another maker, more conservative, may stick to the old nomenclature. Mr. Crosby's suggestion for rating of motors is one not based on the electrical horse-power but rather takes as its starting point the torque produced. For example, if a motor produced a horizontal effort of 500 pounds running at 10 miles an hour and efficiency of 60 per cent., including the gearing, he would rate it as a 500 × 10 × 60 motor. This plan is a strictly scientific one, and if criticism were to be offered it would be that it is too scientific for everyday use. The horse power has become so firmly engrafted in the literature of the subject that it is hard to break away from the use of the term. To substitute for it the comparatively unfamiliar idea of horizontal effort is not altogether easy. While the rating by torque and speed may not be impracticable, we very much fear that including the efficiency factor will prove to be a very difficult matter. Supposing manufacturers and agents to be entirely truthful and quite willing to state the efficiency of their machines, a condition which unfortunately cannot always be enforced, there would still be opportunity for a reasonable difference of opinion as to the point at which that efficiency should be taken. Two motors may give a horizontal effort of 500 pounds at 10 miles an hour and an efficiency of 60 per cent., and yet vary widely in efficiency at other loads. As a matter of fact the efficiency of a motor as a function of the load is never uniform, and no two machines of different types are at all likely to follow the same law; therefore, even with Mr. Crosby's proposed careful rating, there is still a wide margin of uncertainty as to what the motor will do. As regards the other suggestion of standard dimensions, it is far more practicable than a uniform rating, and may not be impossible to put into practice. With respect to nomenclature there is certainly need of reform, and Mr. Crosby's list of definitions is one that might well be put into immediate practice. Almost every company has at present a vernacular of its own for various parts of railway equipment, and there must necessarily be considerable confusion arising in the mind of any one not familiar with all the present systems. Change of practice in this respect is comparatively easy, as it involves no change of apparatus, but only the mental inertia of the rather intelligent class of men who have to use the terms.

The Cost of Electric Traction. ONE of the very valuable reports brought to the attention of street railway managers at Pittsburgh last week was that on the economy of the electric railway due to the investigations of Mr. J. S. Badger, of the Edison company. Though not formally presented before the association the report was distributed and read with the utmost interest. The author had carefully investigated in the minutest detail the operating expenses of a large number of roads, and the results are of the utmost interest and value. One point is especially deserving of attention, and that is in regard to the different performance of similar machinery under different conditions. In the case of one road Mr. Badger states that on an average one-sixth of the armatures in use go into the repair shop every month, while another road of the same system operating more cars on heavier grades had burned out not a single armature in nearly a year. On still another road of less than 10 miles there was for months a constant leakage of from 20 to 30 ampères on the line. This shows plainly enough that the manufacturer is not altogether responsible for the results obtained—in fact that sometimes he is apt to be more sinned against than sinning. Another portion of the paper has to do with the comparison between electric, cable and horse traction based on the actual records of a considerable number of roads. The result is of the most striking character. Into the calculation enter the experience of 22 electric roads, 45 horse railroads and 10 cable roads. Including all the expenses and the interest on cost of plant, the cost per passenger carried amounted on the electric roads to 4.53 cents, on the horse railroads to 4.98 cents, and on the cable roads to 4.77 cents. Taken as a whole the paper shows most admirably the vast difference in results obtained on different roads, and the profound changes that may be made in station expenses by different arrangements of the power producing machinery. For example, the very best performance of any of the roads investigated by Mr. Badger was one electric h. p. at the station for every four pounds of nut coal, or five pounds of slack consumed, and the most striking feature of this altogether exceptional economy of fuel is that it was obtained with a high speed single cylinder non-condensing engine, plain return tubular boilers and a mechanical stoker being used. No more striking example can be found of the truth which we have persistently set forth in these columns, that a simple engine working near its full capacity runs far more efficiently than the very best of the complicated compound condensing engines working under conditions of partial load. In this connection it may be interesting to note the distribution of expense over the various parts of the system; taking the average of the 22 trolley roads above mentioned, the mean expense per car mile was almost exactly eleven cents; by far the largest item of expenditure was the transportation expense proper, including wages of conductors and motor men and the like; this amounted to very nearly five cents per car mile, while the cost of power was but 1.96 cents, including fuel, wages, oil, waste, and other supplies. The repairs per car mile average 1.8 cents. Mr. Badger's investigation is by all means the most exhaustive study of the cost of electrical power on street railways that has yet been published, is of the greatest value to those who are operating such systems and is worthy the careful consideration of practical street railway men and electrical engineers.

Underground and Overhead Systems. MR. G. W. MANSFIELD'S discussion of the dependent system of electric motive power, read at the Pittsburgh convention, is rather a careful investigation of the everyday conditions of electric traction and the possibilities of the various methods that have been suggested for furnishing current to the cars. It takes up in succession the underground service, surface distribution and the overhead trolley system. As regards the first, the view Mr. Mansfield takes is decidedly unencouraging, and while his remark as to the open slotted conduit, that it cannot be made a success throughout our cities to-day, is perhaps true, it certainly must be admitted—in the light of the successful experiment at Budapest, of which a somewhat extended account was published in our last issue—that under favorable circumstances success can be and has been reached. It may not ever become anywhere nearly as widely distributed as is the trolley system, but that it can be used successfully where the nature of the ground and facilities for drainage permit admits of but little question. The financial side of this particular question is even more serious than the electrical one. As regards the modified conduits with insulated sections, contact points, automatic switches, and the like, they are comparatively untried, and hence it is somewhat difficult to take a cheerful view of the situation. A grounded point is not so bad as a continuously grounded wire by any means, and conditions which would insure failure with a continuous bare conductor in a conduit may allow a considerable degree of success where only small portions of the line are in circuit at any one time. Nevertheless there still remains the very serious difficulty of the multiplicity of contacts, a really the point to be feared in any such construction. The surface methods include a long list of inventions, of which the Lineff and the Wheless systems are types. The modified conduit has not yet passed the experimental stage, and it is therefore extremely difficult to predict anything of its future bearing on electrical traction. It involves, like some of the conduits, objectionably numerous switches in many of the proposed forms, but nevertheless it presents some important difficulties. Like most other electric railway men, Mr. Mansfield is a champion of the trolley system, which has unquestionably made a success of electric traction. It is assuredly the method of the present and whatever the future may bring it is a safe system to tie up to until something better appears. A large number of circulars were sent out to street railway men during the preparation of Mr. Mansfield's very valuable report and the answer to them brought out a good many interesting points. Few of them can be touched on here, but one or two things are especially worth mentioning. The wear on trolley wires has been found to be far less serious than was at first feared; in fact, from a long series of measurements it appeared that the reduction in diameter of a hard drawn copper wire amounted to but 1-1,000th of an inch for the passage of 65,000 cars. This augurs small cost of maintenance and very long life for the wire. Another recommendation is the use of material other than iron, preferably silicon-bronze for span wires. Iron is by all odds the cheapest and most valuable material, but rusts badly, and, therefore, the system is seriously weakened; bronze is nearly free from this disadvantage, besides having a higher tensile strength, so that although the first cost is somewhat greater its use probably pays. Our readers will do well to give Mr. Mansfield's paper a thorough reading and preserve it for future reference.

Latest Foreign Electrical News.

(By Cable from Our Own Correspondent.)

London, Oct. 26, 1891.—The electrical exhibition at Frankfort closed on Oct. 19, after a successful career. The aggregate attendance was considerably over a million. During the last days of the exposition Messrs. Siemens & Halske continued their interesting high pressure experiments, and pushed the voltage used as high as 48,000. In one of the experiments a cable made by the Siemens firm in London successfully withstood this very high pressure.

The committee in charge of the Lauffen-Frankfort transmission plant have been trying the experiment of gradually increasing the voltage with a view to determining the upper limit possible with the present apparatus.

Another honor has been bestowed on Prof. H. Von Helmholtz, the eminent German physicist, who has been made privy counselor to the emperor, with the distinguished title appertaining to that rank.

A telegram announces that Caselli, the great inventor of the pantelegraph, and much other electrical apparatus, has died in Florence at the ripe age of 76.

As regards English electrical news, the Thomson-Houston line at Roundhay Park, Leeds, will be formally opened by the mayor of that city on the 29th of October.

The Glasgow municipality is still perturbed as to the electric light of that city and has called in Prof. Rankin Kennedy as consulting engineer.

Meeting of the New York Electrical Society.

The first meeting of the season of this society was held in Prof. Chandler's lecture room at Columbia College on Thursday evening of last week. Owing to the inclemency of the weather the attendance was not as large as could have been wished, but those who were present enjoyed listening to a very interesting lecture by Dr. Schuyler S. Wheeler on the practical management of electric motors. Dr. Wheeler was introduced by Prof. F. B. Crocker, the president of the society, and Dr. Wheeler's well-known associate in electric motor construction. A number of the Crocker-Wheeler motors, both arc and incandescent, were mounted upon the lecture table and were used by Dr. Wheeler to illustrate the various points brought out in his talk. Perhaps the most interesting piece of apparatus was a duplicate of four sets of a dynamo and motor coupled directly to each other, the current generated by the dynamo being used for telegraphic purposes. Dr. Wheeler gave some very practical instructions in regard to the proper unpacking and assembling of the various parts of an electric motor. He described quite minutely the differences between constant current and constant potential motors, explained the use of the combined reversing switch and rheostat, illustrated the operation of the centrifugal governor for arc motors, and described some of the special applications of electric motors. This lecture, Prof. Crocker announced, was one of a series which it is the intention of the society to present to its members during the season in which the treatment of the various branches of electricity will be illustrated by experimental demonstrations. These lectures it is said will be given at intervals of about two weeks.

Moonlight Tables for November, 1891.

Herewith we give Mr. H. W. Frund's table of lighting hours for the month of November, under his modified form of moon schedule:

TABLE NO. 1.
Standard Moonlight, Philadelphia System.

Date.	Light.	Date.	Exting.
1	5:30 P. M.	2	5:30 A. M.
2	5:25	3	5:30
3	5:25	4	5:35
4	5:25	5	5:35
5	5:25	6	5:35
6	7:25	7	5:35
7	8:30	8	5:35
8	9:40	9	5:40
9	10:55	10	5:40
10		11	5:40
11	12:05 A. M.	12	5:40
12	1:20	13	5:40
13	2:35	14	No light.
14	No light.	15	No light.
15	No light.	16	No light.
16	No light.	17	7:00 P. M.
17	5:10 P. M.	18	7:50
18	5:10	19	8:50
19	5:10	20	9:55
20	5:10	21	11:00
21	5:10	22	12:00 M.
22	5:10	24	1:05 A. M.
23	5:10	25	2:05
24	5:10	26	3:00
25	5:05	27	4:00
26	5:05	28	6:00
27	5:05	29	6:00
28	5:05	30	6:00
29	5:05	1	6:00
30	5:05		

Total hours lighting, 222.30.

TABLE NO. 2.
Frund's New Moonlight System.

Date.	Light.	Date.	Exting.
1	5:30 P. M.	2	5:30 A. M.
2	5:25	3	5:30
3	5:25	4	5:35
4	5:25	5	5:35
5	5:25	6	5:35
6	5:25	7	5:35
7	5:25	8	5:35
8	5:20	9	5:40
9	5:20	10	5:40
10	5:20	11	5:40
11	5:20	11	12:00 M.
12	5:20	12	12:00
13	5:15	13	12:00
14	5:15	14	12:00
15	5:15	15	12:00
16	5:15	16	12:00
17	5:10	17	12:00
18	5:10	18	12:00
19	5:10	19	12:00
20	5:10	20	12:00
21	5:10	21	12:00
22	5:10	22	12:00
23	5:10	24	1:05 A. M.
24	5:10	25	2:05
25	5:05	26	3:00
26	5:05	27	4:00
27	5:05	28	6:00
28	5:05	29	6:00
29	5:05	30	6:00
30	5:05	1	6:00

Total hours lighting, 222.35.

The Pittsburgh Street Railway Convention.

The tenth annual convention of the American Street Railway Association at Pittsburgh went off with éclat. There was a larger attendance, a larger number of exhibits, and larger numbers of places in which to hunt for them than at any previous convention. The delegates were distributed over a greater number of hotels, hunted for each other with more unrewarded pertinacity, and as a consequence did more general kicking than on any similar occasion. The clans began gathering by as early as Monday, Oct. 19. The large companies who had exhibits for the first comers were a busy crowd, intent on unpacking and arranging machinery, hunting accomodations and getting on the soft side of the Pittsburgh newspaper reporters—all of which feats were accomplished with distinguished success.

A street railway convention is nothing if not businesslike, and once the delegates gathered the meetings began. The special train annually run to the convention by the Lewis & Fowler Company, of Brooklyn, arrived during Tuesday night. Other delegates from Philadelphia, Boston, New York and the West reached Pittsburgh in large numbers on Wednesday morning, and everything was in working order, the delegates were wide awake and the still hunt for business was under way. The Street Railway Association is in striking contrast with the Electric Light Association in the number of active members present, so that the main hall in which the daily sessions were held was invariably well crowded, while there seemed to be no perceptible reduction in the throngs that took the corridors of the hotels by storm. The local committee, which had been most industrious in making preparations, looked after the delegates in every way, presented every one with a little book of free tickets over the street railway lines, and in a general way lent a helping hand at every opportunity. Much credit is due the members of this committee for their many courtesies to those in attendance.

In a slight attack of over-enthusiasm, two barges had been moored in the river close to the Monongahela House, and these allowed a puzzling distribution of exhibits. Others were in the hotel, on every story, and in the corridors. Still others were scattered wherever they could find lodgment. The lack of a suitable hall for holding the entire display made itself felt in a serious manner, and it is to be hoped that next time there will be more ample accommodations.

A large part of the actual business of the association was transacted on Wednesday, when there were three sessions, morning, afternoon and evening. The first session was devoted principally to the formal opening of the convention, the latter two to the reading and discussion of the papers. These, with the exception of a single report on progress in cable traction and another report on the treatment of corporations with regard to taxation, were electrical from start to finish, and were of a high order of merit. Special mention ought to be made of the papers of Messrs. Crosby, Mansfield and Badger, the latter not read but distributed in pamphlet form.

On all sides of the hotel were displayed cars and trucks. The Thomson-Houston, Westinghouse and Short companies had special cars for the display of their latest motors, while the Edison company attended to the big residual crowd in the hotel by making the wheels go round in its own rooms. The three former companies also had exhibits of an interesting character on the barge, where the Thomson-Houston company showed its standard type of motor, including the very interesting new single reduction motor known as the W. P., of which a somewhat detailed description will be found in another column.

The Short company had a fine 150-h. p. generator driven by one of its double reduction motors operated from the street railway circuit and furnishing current to a gearless motor located near the gangplank. The single reduction gear motor was also shown. The Westinghouse company had its standard trucks, including the gearless and an additional magnificent "bluff" in the shape of one of its single reduction gear motors running under water in a great tank—not that its street railway motors are intended to run under water, but the exhibition was a fine example of good insulation. On the street car tracks the Thomson-Houston took the warpath with a beautiful long car mounted on radial trucks and equipped with two of the new W. P. motors. The Short company followed suit with a fine gearless car that carried crowds over the road, while the Westinghouse contingent had a gearless car in regular service, resplendent with flags, and running like a scared cat every time the track was tolerably free of obstructions. The great Westinghouse factories were open for the inspection of visitors, and throngs of delegates visited them. Specially interesting, too, were the magnificent railway generators there shown—beautiful pieces of mechanical work and running under all sorts of loads without noise or perceptible spark. There were also all the types of Westinghouse railway motors mounted for testing purposes, the latest Westinghouse alternating motor, and all the details of manufacture of miscellaneous electrical machinery.

Another most instructive and beautiful display, although not electrical in its character, was that of the Oil Well Supply Company at its exhibition building, where were shown working models to scale of the complete machinery used in drilling and operating oil wells, beside all the standard devices and appliances for that purpose. Carriages were in attendance and a large number of delegates visited this display, which was exceptionally striking in every way. Most of the large manufacturing establishments in Pittsburgh followed the example of the company by throwing open their works to visitors, and there was every opportunity for the inspection of a wide range of electrical and allied manufactures, an opportunity which was taken advantage of to the fullest extent.

Thursday concluded the regular sessions of the convention, and after a considerable amount of discussion Cleveland was selected as the place for the meeting of next October, a choice that was generally indorsed, as Boston, the next favorite, was considered too far east for the convenient attendance of many of the active members. Cleveland possesses advantages for railway men in that a number of systems are in considerable use there, while the great West End system practically employs but one.

Thursday night was the occasion of the annual banquet, and nearly 600 of the visitors sat down in the immense dining room of the Monongahela House, which had been most beautifully decorated for the occasion, to an elaborate dinner, followed by very pleasant post prandial speeches. The menu was a most artistic affair, bearing on its last page a fine emblematic picture of the modern history of street railroading. The idea is so bright that we reproduce the illustration in this issue for the benefit of those who could not be present at the convention.

On Friday there was more attention paid to pleasure than to business. A large party embarked on the barge Mayflower and spent the day most agreeably in a sail up and down the river, with visits to the works of the Oil Well Supply Company and to the splendid Carnegie Steel Works, while another smaller but equally enthusiastic contingent of the delegates accepted the invitation of the Pittsburgh, Allegheny & Manchester Street Railway Company to inspect its new power house and car barns. The power house is a fine example of modern power stations, equipped with two 500-h. p. compound condensing Corliss engines and multipolar Thomson-Houston generators of various sizes. The switchboard is an especially fine example of convenient arrangement and a model that might well be followed elsewhere. From the power station the visitors repaired to the car barn, a large and most conveniently arranged structure with every convenience for handling and shifting the cars. Here was a surprise in store in the shape of an elaborate luncheon elaborately served in a corner of the building, partitioned off with cars for that purpose. After enjoying the hospitality of the company here, most of the delegates embarked on the Thomson-Houston special car for a long trip over the system. This car, as before mentioned, was fitted with Robinson radial trucks and the latest form of motor. To display the latter one of the traps in the car floor was lifted up so that its smooth and noiseless running could be better appreciated. About one o'clock the car started out on the long run, making excellent speed and, thanks to its truck gear, swinging around sharp curves with the greatest facility. After a thorough test of the capabilities of the car, it was brought back to the car house, stragglers were picked up, and the delegates came back to the city to prepare for their departure that evening.

It was after six o'clock before the hilarious barge party returned from the Carnegie Works, and there was quite a necessary skurrying around to catch the evening train. All through the afternoon the displays were being thinned out by packing, and when at about seven o'clock the great mass of the delegates appeared at the Pennsylvania station the hotels were pretty sorrily shorn of electrical glories. As usual, the special train was a little late in pulling out. The Lewis & Fowler cars took precedence, followed by half a dozen handsome Pullman sleepers filled with other returning delegates. Some waited until later trains, and farewells were said—quite unnecessarily, however, as the party were fated to meet again about 75 miles out of Pittsburgh, where a prosaic and exasperating freight wreck had been in progress. The entire road was blocked until the dim hours of the morning twilight, when the procession got under way again with the trains massed in two sections, and running on the time of the express that left Pittsburgh at one o'clock the same morning. It was a tired but good natured throng that met at the Harrisburg station Saturday morning for a breakfast at the hitherto unparalleled speed of something like 200 miles an hour. After that trial was over the terrors of the journey were nearly at an end, and the great mass of the attendants at the street railway convention pulled into New York seven hours late at 2:30 on Saturday afternoon. Of the more fortunate Western contingent we are unable to speak, except to say that it is to be presumed that it escaped safely homeward.

Thus ended the Pittsburgh convention, which may be counted as a signal success, both in the size of the attendance and the number and character of the exhibits. The papers were as a rule of the most interesting character, and the only thing to be regretted was the absence of that full discussion which adds so much to the value of such proceedings. At the next meeting an effort will be made to have all the papers printed and distributed before the convention, so as to give the delegates the advantages of critically examining them before arriving on the scene. The working sessions will thus be devoted largely to a careful discussion of the statements brought forward. Such a

course is highly to be commended, as it much increases the usefulness of the careful work that has been done. Most papers read at such gatherings are of so thorough and elaborate a character that no cursory inspection will bring out their full merits, and by giving a little time in advance for their consideration a formidable array of useful information can be drawn from the collected experience of the able and practical men who constitute the American Street Railway Association.

It was truly said at Buffalo last year that the horse had made his last official appearance, and the Pittsburgh convention gave every indication of being a sort of formal farewell on the part of street railway men to their four-footed former allies. Not only was good-by said at the banquet, but most of the delegates went through the convention wearing with presumable complacency a very neat badge distributed through the courtesy of the Electrical Supply Company and bearing on its face the pleasing legend "The Mule Must Go." With every succeeding year electricians will feel more and more at home at the street railway conventions, and unless the signs of the times are all at fault a few years more will see nothing to rival them except the small and presistent delegation of cable railway men. The electric railway has come to stay and the upholders of the mule are undergoing a conversion exceeding in rapidity the wildest dreams that ever entered the mind of the most enthusiastic Bellamyite in his imagination of the possibilities of the future.

The Motor of the Frankfort-Lauffen Transmission, and Three-Phase Motors in General.

BY CARL HERING.

In addition to what has already been published in these pages regarding the Frankfort-Lauffen transmission of power, the following, regarding the motor, may be of interest.

The description of the dynamo published in THE ELECTRICAL WORLD Aug. 22 was made while the writer was visiting the Oerlikon Works in Zurich, where it was constructed, and he was informed then that the motor was to be the exact duplicate of the dynamo. This, however, is not the case, and the statement must have referred to other installations which they are making with this type of dynamo. In the Frankfort-Lauffen transmission the motor is radically different from the dynamo, as the readers of THE ELECTRICAL WORLD will have noticed from subsequent descriptions. To have the motor just like the dynamo would be to lose some of the chief advantages of the "rotary current" system, which lies in the fact that it enables unsynchronal motors to be employed. The counterpart of the dynamo could doubtless be used as a motor, but it would have to run synchronously, with an exciting current, just as the usual alternating current motors.

The material from which the description of the motor published in THE ELECTRICAL WORLD of Sept. 26* was made was obtained under very unfavorable circumstances, at a time when the inquisitive public had to be shut out from the room in which the exhibit was, by iron doors and drawn curtains, and the employés seemed to have been sworn to secrecy, all of which was doubtless justified under the circumstances. It was quite difficult therefore to get facts about the motor. A complete description has not yet been published, and probably will not be for the present. Until it is published, the following short description of this class of motors, based chiefly on inspection and on some scant information, may be of interest:

Imagine two concentric, laminated iron rings, precisely like the cores of a Gramme ring armature. The outside one is fixed, and we will here call it the field for simplicity sake; the inside one revolves on the shaft, and will here be termed the armature; there is a small annular air space between the two which corresponds to the air gap in any other dynamo or motor. The field ring has a series of small holes parallel to the shaft, quite near to its inside surface; the armature has a similar series of holes quite near to its outside surface. In each of these holes is a copper rod insulated from the iron; these rods together with their end connections form the windings of the field and armature respectively. It will be noticed therefore that there are no coils and no wires; the whole winding is built up of rods and end connections, making a very simple, cheap and rigid construction. The end connections between the rods are made with the usual bracket shaped (⌐¬) connecting pieces, making a symmetrical, rosette shaped figure at the ends.

The exact nature of the winding could not be ascertained, but the following is the general principle of it, and will serve to explain the action of the motor. Imagine the

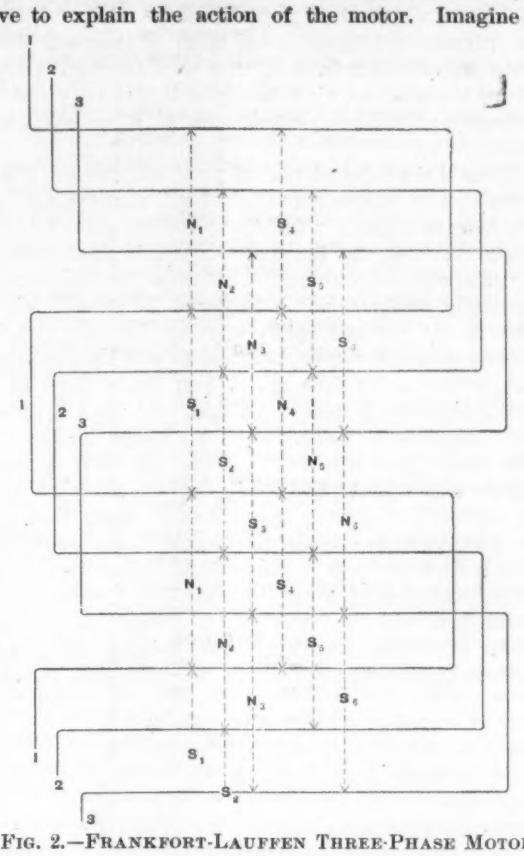


FIG. 2.—FRANKFORT-LAUFFEN THREE-PHASE MOTOR.

wires on the armature to be numbered successively 1, 2, 3, 1, 2, 3, 1, 2, etc.; now let all those numbered 1 be connected in series by cross connections between each two wires at alternate ends of the armature, forming a zigzag winding under the whole cylindrical surface (Fig. 1); let the same be

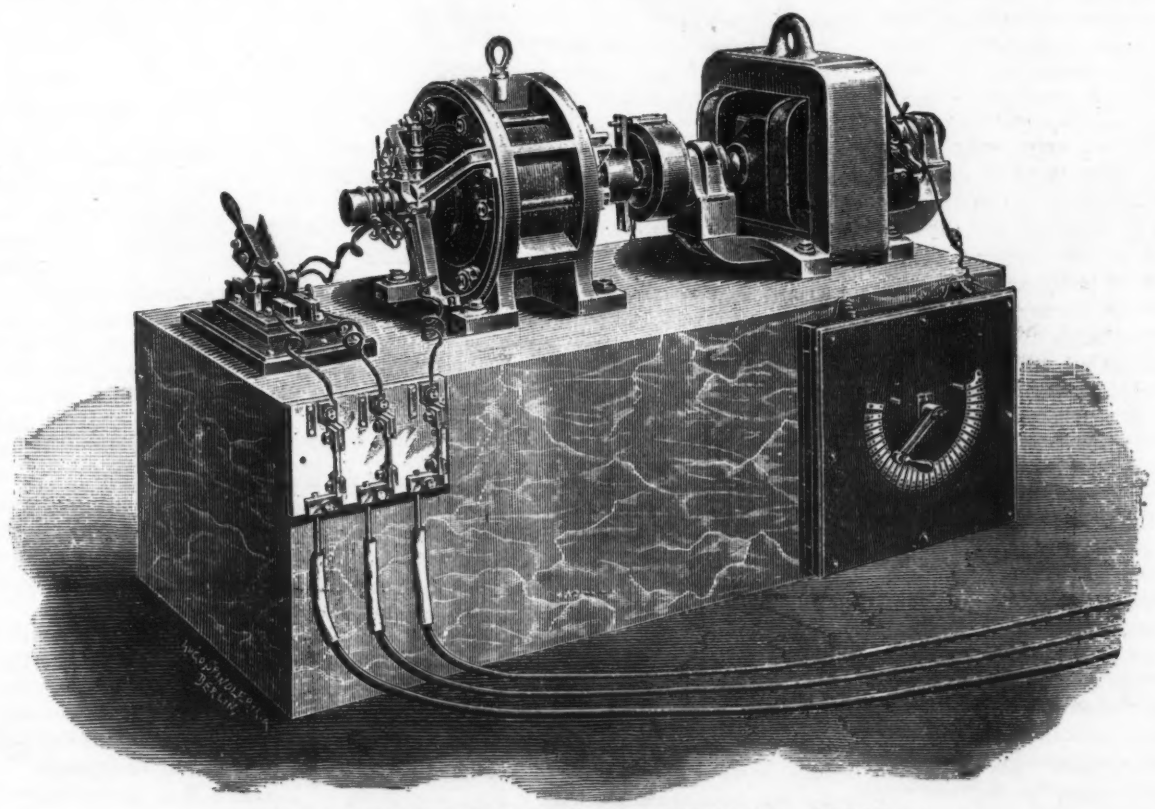


FIG. 3.—FRANKFORT-LAUFFEN THREE-PHASE MOTOR.

done with those numbered 2, and also those numbered 3. This will give three independent windings, each one being, in position, slightly in advance of the other, and by a distance equal to one-third the space between two wires of the same circuit. Suppose now a momentary *positive* current is sent through the series 1; there will be produced on the cylindrical surface of the armature between the zigzag windings as many alternate north and south poles as there are wires in this circuit, as seen in Fig. 2, in which

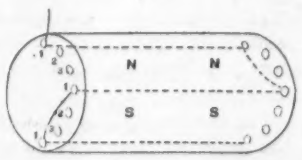


FIG. 1.—FRANKFORT-LAUFFEN THREE-PHASE MOTOR.

the poles produced by this current are numbered N_1, S, N_1, S_1, etc. In this particular motor we believe there were eight such poles. Now let a similar momentary positive current be sent through circuit 2 and then through circuit 3; the same north and south poles will be produced as before, but they will be moved forward slightly in each case as seen in this figure. Let this third current be followed by a *negative* momentary current in circuits 1, 2 and 3, successively; this will produce the *same* poles as before (marked N_4, N_5, etc.), each time slightly advanced in position around the armature. Such successive momentary currents in these three circuits, following each other regularly and reversed in direction at every third impulse, will therefore generate a multipolar field quite like so many radial poles, which moves quite regularly around the surface of the armature without reversing its polarity. Now, three *alternating* currents differing in phase by one-third of a wave length will, if passed into these three circuits, act in precisely the same way (and very much better, of course) as the three successive momentary currents used in this illustration, and periodically reversed in turn.

If a series of alternate north and south field magnets be placed around this armature, to hold the field in one place, then the armature will evidently rotate, and with exactly that speed with which its own fields would have revolved around it had there been no external field magnets; it will evidently turn in the opposite direction to that of its own fields. This would make a synchronous motor, that is, one which must run in unison with the alternations. Motors of this kind were exhibited by other makers. If, instead of these external field magnets, a solid (not laminated) stationary iron ring is placed around this armature, it will resist, to a great extent, the movement of this revolving field, and by this opposition will tend to turn the armature in the opposite direction. Small motors are built this way and work very well, and are evidently very cheap.

The resisting action of this solid iron mass on which the principle of the motor depends, is due to the fact that the revolving field of the armature generates Foucault currents in this iron, and these currents oppose those in the armature. But it is claimed that such Foucault currents circulate promiscuously, as it were, in the iron and are therefore not always in the position to do most good. In order to direct them, the inventor of this motor laminates this outside iron ring and runs copper bars through it in the holes which were mentioned in the early part of this description. The induced currents therefore flow through these bars instead of through the iron.

In some of the motors which he builds, one of which will be mentioned again below, these bars, in what we have termed the field, are simply connected together at their ends to common rings, short circuited in other words. The currents induced in this short circuited winding by a regular transformer action will be just strong enough to produce the required torque; for instance when starting the motor they will be very great and will therefore generate a very powerful torque; when the motor is running at full speed, say without a load, they will be very small, because the armature will revolve almost as fast as its own fields tend to do in the other direction, and therefore its own fields will be almost fixed in position; they will not be quite fixed, however, for if they were, there would be no currents induced in the short circuited stationary field winding. Let us call the speed at which the magnetism of the armature rotates (which evidently depends only on the number of alternations and on the nature of the winding, and is therefore a fixed quantity) the theoretical speed; then the difference between the actual speed and the theoretical speed will express the number of times that this armature field actually revolves when the motor is running; let us call this the lagging of the speed. This lagging speed, or the actual rotation of the armature field, is what induces the current in the stationary field circuit. At the moment of starting, the lagging speed is a maximum and is equal to the theoretical speed, because the armature is at rest; the induced current in the short circuited coil is therefore very great, which is a very good feature. At full speed, without load, the lagging speed is a minimum, and for a theoretically perfect motor it would be zero. Furthermore, the armature of such a motor will take, or absorb, current about in proportion to the work it is doing, like a transformer. At the moment of starting it is, in fact, simply a transformer with a short circuited secondary; at full speed, without load, it will act like a transformer also, but one in which the number of alternations will be proportional to the number of lagging revolutions; as the latter is small the transformer action will be small, and the motor will act more like a choking coil, or a transformer with an open secondary. As the load is increased the speed will tend to fall, the transformer action will increase and so will the induced current in the secondary, which in turn tends to increase the speed again by increasing its opposition to the revolving field.

* In this there are two important typographical errors. Page 233, third column, twenty-second line from the bottom, "arc" should read "no." Second line from the bottom "even" should read "iron."

As we have just seen, the current in the short circuited field windings will be very great at starting. For a large motor this would be a strain on the armature current, and therefore, on the leads, measuring instruments, fuses, transformers and generator in that circuit; it would also affect any lamps or other motors on the same mains. To overcome this, the field circuit of the large motor used in the Lauffen transmission is not short circuited, but is connected by leads to a hand rheostat, by means of which this circuit can be opened or closed on a gradually diminishing resistance, and finally short circuited. This resistance was made of three iron tanks containing a solution of soda, and three movable, pointed iron plates which may be gradually lowered into this liquid and finally cut out by a short circuiting switch when they are fully immersed. On starting this motor, the field circuit is first opened, the current is then switched on to the armature; as we have seen, this current will be very small, as the armature will act like a choking coil or like the primary coil of a transformer with an open secondary; the armature will furthermore have no tendency to revolve. The field circuit is then closed through a high resistance by means of the hand regulator; the armature then begins to revolve slowly. By gradually diminishing the regulator resistance the speed of the armature is gradually increased (with or without load) until it reaches its maximum, when the field circuit is finally short circuited. It will be seen, therefore, that such a motor is entirely under the control of the engineer. It can be started gradually with or without load, and can be maintained at any desired speed from the maximum down to zero. It can furthermore be reversed by a simple switch which reverses the connections of two of the three currents; for instance, if the three circuits are numbered 1, 2, 3, and the waves follow each other in that order, then by reversing the connections of any two, say numbers 2 and 3, the succession of the waves will be in the order, 1, 3, 2, 1, 3, 2, 1, etc., and the rotation of the revolving armature field will therefore be in the opposite direction.

It may be well to call attention again to the fact, which is frequently overlooked in descriptions of this three-phase system, that the chief advantage of the system lies in the fact that the motors are so simple, reliable and unsynchronous, and that they may be started and reversed gradually, loaded or not; in other words, that they are under complete control. In these respects the motors are not only quite equal to continuous current motors, but owing to the fact that there is no commutator at which sparks will be produced, they will stand what no continuous current motor can stand. This was shown by a small exhibit adjoining that of the large motor. This exhibit is shown in Fig. 3. It consists of a small three-phase motor of about two h. p., coupled directly with an ordinary continuous current dynamo. The field of the motor was permanently short circuited and the armature current was furnished with a reversing switch seen in the figure. The dynamo was connected to a batch of lamps and answered merely as a load or dynamometer for the motor. To start this motor the current was simply switched on without any starting resistance; it started quickly but without noise or jar. It was then loaded with double its normal load, that is with four h. p., to show that it could stand an abnormal, load without stopping; its speed was only slightly diminished thereby. It was then started loaded with this abnormal load with the same result, requiring but two to three seconds to come up to speed. In order to tax it still more, the field of the dynamo was separately excited, in which case the motor did not have the advantage of the few moments which it takes at starting to excite the dynamo field. Lastly, and the most severe test of all, the current for the motor was reversed instantly while it was at full speed loaded with double its normal load, the dynamo being separately excited. It responded so quickly, requiring only about four seconds, and with so little noise, that it was only by close watching that one could notice the actual moment of reversal. Surely there is no well-constructed continuous current motor that would stand such a severe test.

(To be continued.)

The Elements of Practical Electricity.*

BY DR. LOUIS BELL.

EFFECT OF AN ELECTRIC CURRENT ON A MAGNETIC NEEDLE.

The last experiment has brought to your mind the idea that when an iron bar is magnetized magnetic action or magnetic force is not altogether confined to the iron or to its immediate surface, but extends through the surrounding medium, whatever it may chance to be. In a similar way you are now going to look into the properties of a wire through which an electric current is flowing. At first thought—because breaking the circuit will rob an electromagnet of its power, stop electrolytic action and suspend almost any of the experiments you have tried—it would seem that the effect of the electric current is confined to the wire which carries it. Breaking the continuity of the wire undoubtedly does prevent the appearance of certain electrical phenomena, but you have come to realize from the method of making an electromagnet, that a wire which carries a current is capable of producing very considerable effects in material that is wholly out of contact with it. The wire with which you wound your electromagnet was insulated and in the case of the magnetizing coil there was no contact, save by air, between the wire and the needle or rod in the coil, yet these were strongly magnetized. Later a number of striking experiments will show you that the most important effects of an electric current are those which are manifest only outside of the wire, and that just as a permanent magnet gives signs of magnetic force at some little distance from it, so a wire carrying a current affects the medium, air or whatever it may be, about it and is capable of producing effects even at a considerable distance.

Connect the poles of one of your bichromate cells by a piece of stout copper wire (No. 16 will answer), a couple of feet long, straighten a few inches of this wire by holding it tense between the fingers and bring it down close over the glass cover of your pocket compass; the needle will immediately swing so as no longer to be parallel with the wire, and if you attempt by shifting the wire to bring it directly over the needle, the needle will keep on moving and getting out of the way. If you fasten the wire down over the compass in any position, and then reverse the connections at the battery so as to change the direction of the current, you will find that the needle recognizes the change immediately, and swings across the wire, making an angle with it on the opposite side. More than this, if you keep your eye on the north pole of the needle as the wire is stretched over it, you will find that there is a systematic relation between the direction of current and the direction in which the north pole swings away from the wire. If the wire is brought down over the compass while stretched in a north and south direction with the current

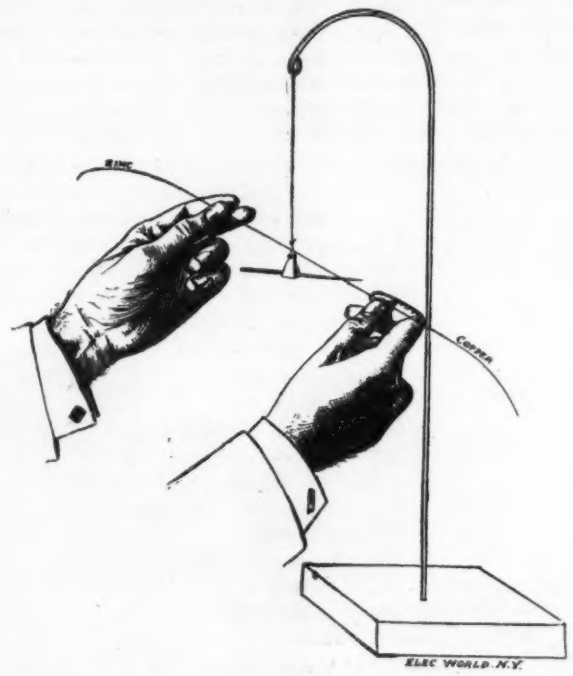


Fig. 15.—Apparatus for Showing the Effect of an Electric Current on a Magnet Needle.

flowing from south to north, the north pole of the needle will swing toward the west; if the current be reversed it will swing toward the east. So you see the compass gives you a means of telling the direction of the electric current in a wire just as it enabled you to pick out the north pole of a magnetized needle, and in either case the action can readily take place at quite a little distance. As a pocket compass often has its needle not very delicately suspended you can best try further experiments on the relation between an electric current and a magnet that is free to swing by constructing the apparatus seen in Fig. 15, which may readily be made from a piece of board and a stiff copper or brass wire bent as shown, with a little loop at the projecting end. Magnetize a small sewing needle and suspend it from this loop by thrusting it through a very small thin paper loop, as shown in the cut. This loop should be suspended by a small bunch of silk fibres, such as can best be obtained by unraveling a bit of silk floss. With a little care you can pull out a bunch of fine fibres five or six inches long, and the fewer fibres in this bunch the better, for a single one is quite strong enough, although inconveniently small to handle without some experience. The fibres should be thoroughly untwisted and then one end of the bunch fastened with a little mucilage to the paper loop, while the other end, after the mucilage is dry, may be gummed or tied to the supporting wire. Now balance the magnetized needle carefully in the paper loop, when it will swing slightly and then take up a north and south position. The best way of magnetizing the needle is not in the magnetizing coil itself but by placing it across the poles of your little electromagnet, about which you should wind a considerably greater number of turns of wire than in the first experiments, carrying as strong a current as your battery is capable of giving. Now connect the poles of one of your bichromate cells as before, hold the wire as shown in Fig. 15 and bring it close down over the suspended needle, when the north pole will swing to the west or east according as the current is flowing from south to north or the reverse. Place the wire immediately under the needle and the condition of things is reversed: the north pole swings east when the current is flowing from north to south, and west when flowing from south to north. Whatever the direction of the current the effect on the suspended magnet can be predicted by remembering the following simple rule due to Ampère and often known by his name. Imagine yourself swimming with the electric current and facing the magnet, whether it is above or below you; the deflection of the north pole of the needle away from the direction of the current will be always toward your left hand. But a magnetic needle free to move can tell us far more than the mere direction of a current. If you hold the wire that carries the current above the needle and bring it gradually down until it is as near as it can be without touching, you will see that the magnetic pole swings further and further aside as the wire gets nearer to the needle. In other words, the effect of the current on the magnet increases as the distance between them decreases. Go back to the pocket compass, stretch the wire close down over the glass and fasten it in position by placing books on the two sides of the compass, or in any other convenient way; the needle will be deflected and will take up a certain position which you can readily recognize by looking down and seeing the position of the needle on the compass card. Disconnect one end of your wire from the battery without disturbing that portion of it over the needle, twist on to its end a piece of No. 18 wire 15 or 20 feet in length, and connect the other end of this to the battery so that the current, instead of flowing through a short and comparatively thick wire, flows through a considerably greater length of smaller wire. The compass needle will be decidedly less deflected under this new arrangement than with the old, the battery being the same in either case. But you will readily understand that less current will flow through the long and small wire than through the short and thick one, even though they are of the same material, just as in the early experiments with the voltaic pile certain substances were found to permit the current to pass less freely than others. The experiment you have just tried introduces you at once to two very important facts, one of them the effect of resistance in hindering the passage of the electric current and allowing less current to pass, the other that there is a relation between the amount of current and its effect on a magnet placed at a given distance from it. In other words, the deflection of a magnetic needle enables one to distinguish between different strengths of current; in fact to measure the current, and not only that but the effect of resistance in diminishing it.

(To be continued.)

Meeting of the Chicago Electric Club.

At the last meeting of the club the address of the evening was made by Prof. Elisha Gray, on "The Electrical Congress of 1893," the full text of which was given in the last issue of The Electrical World. After the address, Colonel R. C. Clowry, chairman of the committee on Electrical Appliances of the World's Fair Directory, followed with an indorsement of the remarks of Prof. Gray about the importance of taking hold of this matter promptly and thoroughly; and then briefly referred to the work already accomplished in the electrical section and that outlined for the immediate future.

Mr. John P. Barrett, Chief of the Electrical Department of the World's Fair, was then introduced, and made a few characteristic remarks, in which he expressed to the members of the club his hearty appreciation of their efforts in forwarding the good work and promoting the interests of a fair "that is going to be too big for any one to get in its way."

Mr. B. E. Sunny then made some excellent and pertinent remarks regarding the immediate value to the scientist, the engineer and the manufacturer, of the work that would be brought before the coming Electrical Congress, and of the importance of having the practical electrical units officially designated. He pointed out that much remains to be done in the work of formulating a programme for the conference that will simplify its labor to the utmost, enabling results to be secured that will reflect great credit on the participants and lessen the labor of the electrician. Referring to the growth of the different branches of the electrical industry, since the Paris conference was held in 1891, Mr. Sunny said: "Arc and incandescent lighting came into general commercial use after 1883, and since that time about 325,000 arc lights and 3,500,000 incandescent lights have been installed, calling for an investment of approximately $275,000,000, while within the last five years 354 street railways have been equipped electrically with 4,513 cars, running over 3,000 miles of track, representing an investment of $21,000,000, omitting the cost of the usual accessories, such as steam plant, overhead construction, etc." Regarding the storage battery, Mr. Sunny said: "Of all the new developments in electricity, none has proven so attractive and promised so much as the storage battery, and that the difficulties in its practical use will be speedily eliminated, can be regarded as a foregone conclusion."

Mr. Sunny is chairman of the Committee on the World's Fair of the National Electric Light Association, and in referring to the interest that association has in the final success of the electrical section said: "Everything in the power of that association will be done to further the work of the electrical congress."

Mr. Sunny's remarks, and also his active work as a citizen, as a director in the World's Fair, and as chairman of

* Continued from The Electrical World of Oct. 24, 1891.

various committees, in promoting the welfare of the electrical section in both its theoretical and practical branches, and in giving liberally of his time and attention to these matters, irrespective of any personal desires or of business connections, shows a generous spirit that cannot be too highly commended.

Mr. Kempt then called on the Hon. George B. Shaw, of Eau Claire, for a few remarks, and Mr. Shaw replied with an amusing story about Mr. Kempt's early days, and then, indorsing Mr. Sunny's remarks regarding the importance to the manufacturer of having the units officially standardized and adopted, said that in view of the wonderful spirit of enterprise that has been developed in this city, he would suggest the word "Chicago" as the proper name for the unit of success. Mr. Shaw paid a high tribute to the spirit shown by Mr. Sunny and Colonel Clowry, and other active business men, in devoting so much time to advancing the work of the World's Fair "in which we of the Northwest feel that we have a sort of proprietary interest and will do all we can to make it a success."

Mr. W. H. Dyrenforth, Mr. D. W. Tripp, Mr. St. John Day, Mr. F. G. Beach, and Mr. C. H. Wells all followed with short but pithy remarks, and then Mr. F. W. Parker made a very happy speech, in which he referred to the grand practical work America had done in the electrical field: "The real fundamental work of the Fair is to bring men together, to awaken sympathies in common, to develop that which is best, to concentrate and to unify."

A generous supper then followed, during which toasts were responded to by Mr. D. A. Ranck, of Fremont, O.; Dr. V. T. McGillicuddy, of Rapid City, Dak., who was prevailed upon to say a few words about his Indian experience when serving under Generals Custer, McKenzie and Crook; Chief Swenie, of Chicago; Mr. H. B. Cobb, and others. Among the friends from out of town were Prof. C. S. Page, of Champaign; Mr. Ed. F. Williams, of Buffalo, and Capt. Willard T. Candee, of New York.

The club rooms were suitably decorated with palms, ferns, potted and cut flowers, and the meeting was one of the most enjoyable in the experience of the club.

Edison Says the Locomotive Must Go.*

There is only one man in the world who could say it—say it and have the world listen while he said it.

What he said was, "Yes, it will displace the steam locomotive."

The man is Thomas A. Edison, and he said it to a *Herald* reporter yesterday morning, standing in the office of his Concentrating Works at Ogden, N. J., and talking of his newly perfected motor electric systems for steam and street car roads.

"It will displace it," continued the inventor in an offhand way, "if economy, as well as speed and safety, is a factor of locomotion, not because it will make easily a speed of a hundred miles an hour while steam strains itself to make 60, but because it will get one horse power out of from one to two pounds of cheap coal, while out of six pounds of dear coal a locomotive engine can only get that same one horse power. It will displace it because it will be cheaper."

"When will it displace it?"

"It will begin to do it between Chicago and Milwaukee at the World's Fair."

Thus the greatest of modern wizards stood in his mountain retreat and calmly announced the ending of the wonderful old era of steam locomotion, the birth of the new era of perfected electric travel, and fixed the date at 400 years after the discovery of America.

The top of Ogden Mountain, where the Wizard, as a diversion from his more serious business of making a-hundred-mile-an-hour motors, charms Bessemer iron ore out of the rock of abandoned mines with his magnetic separator, is the highest and the loveliest spot in the State of New Jersey. Here he is coining money out of refuse; making ore out of which the Bethlehem Steel Works will forge their $5,000,000 worth of guns for Uncle Sam.

And thus the Wizard spoke: "The problem of electric locomotion on what are now called steam railroads is a wonderfully simple one. The street car problem was the poser. Any electrician can run a train at high speed on a steam railroad track.

"Why, eleven years ago, I ran a train at the rate of forty miles an hour on my three-mile track at Menlo Park by the same central rail system by which I propose to run now, ran it round curves at such a rate that the people wanted to walk back. I had Frank Thomson and all the Pennsylvania Railroad people riding on it. I wanted to begin at the big end of things. I wanted to run all the trains on the Pennsylvania Railroad from Jersey City to Pittsburgh by that system, and I could have done it then. But in pioneering you have to begin at the little end, so I went into the electric light. And in pioneering you have to have a man with nerve to adopt your ideas. I have found the man. He is Henry Villard. It is his idea to have this system in operation between Chicago and Milwaukee during the World's Fair. He intends to demonstrate that there need be no such thing as waiting for trains between cities now considered a long distance apart. He intends to run a train, say, of two cars, every twenty minutes.

"I would not be surprised after that to see him introduce the system over the whole of the Northern Pacific lines, though he would not be compelled to introduce it all at once and throw away all his locomotives. By this system electricity can be gradually introduced, more trains being sandwiched in between the steam trains as the locomotives wear out."

"How can that be done and how will the current be applied?"

"I cannot go into details," replied Mr. Edison, "for fear of injuring my rights on the other side—though, by the way, I never made anything out of European patents—but I will say briefly that the current will pass from the stationary engine to a central rail between the tracks, thence through the mechanism attached to the bottom of the cars or motor. A freight train, of course, would need a motor because of the number of cars, although a single passenger car could be run carrying its own motor beneath it—thence to the wheels, and thence back by the side rails to the power house or stationary engine."

"And how many of these stationary engines would be needed?"

"Three of them with a horse power of 10,000 or 12,000 each would run the whole Pennsylvania railroad system between here and Philadelphia."

"Freight, local, express trains and all?"

"All of them and at a great reduction of expense. Not only is each horse power produced at much less expense, for you must bear in mind that it is one or two pounds of cheap coal that will produce one horse power in a stationary engine and six pounds of dear coal in a locomotive, but the depreciation of rolling stock and road bed is much less. Every exertion of steam power is in the nature of an explosion, and when you take into consideration the fact that four or five hundred engines are on a road like the Pennsylvania at one time, each exercising a different degree of this explosive power, the depreciation is a great factor. But with electricity it is always the smooth, rotary motion, imparted in the same way by the same men at the stationary engines."

"Can equipment be devised which will stand the strain of this system at full speed?"

The Wizard smiled. "Full speed of this system," he said, "is, or I see no reason why it should not be, 200 miles an hour. But as for practical purposes I feel sure that a 100-pound rail on a rock ballasted track would stand the speed of 100 miles an hour."

"And how will your train be stopped?"

"By air brakes, the same as at present; and that is about all the one man who would take the place of engineer and two firemen on the present express trains would have to do—keep a lookout and mind his brake."

"Your system will be indispensable for the rapid transit tunnel, when completed, if it is completed?"

"Any electrician ought to be able to drive a train at the rate of 40 miles an hour," was the modest answer. "Siemens ran the first electric railway."

"But since you dropped the subject, eleven years ago, at Menlo Park, no electrician seems to have got very far with it?"

The Wizard only smiled a deprecatory, apologetic smile and said: "They certainly ought to be able to get the capital for that tunnel if there is a provision against parallel lines, even if it is $90,000,000. You see, anything will pay in New York if the people want it. I have been working on the street car problem for two years. As I told you before, any electrician can get high speed. One thing was to get low speed to run four or five miles an hour when necessary. And then the grades. Why, some street car grades are 12 per cent. With railroads the highest is generally two per cent. And then the mud. Well, I can pick the current up out of two inches of mud. I have done so on my experimental track down at Orange; but, I can tell you, it took all kinds of contrivances to do it."

"Is the system the same as that for the railroads?"

"No; there was another difficulty. The thing was to get a system which a man such as street car lines have to employ could operate without knowing about it. To make it more simple for him makes it more complex for us. Of course I have the stationary engine, but for simplicity's sake I have abolished the central rail. The current passes along one side rail to the motor and back to the stationary engine through the other."

"But in a city street will not conditions arise that will distract the current running along a naked rail under wagon wheels?"

The Wizard smiled again, as if to say, "That's an easy one," and replied: "There are four fire engines in the city of New York which have iron wheels and we'd have to look out for them somehow. But those are the only vehicles, so far as I know, of the thousands in use there which have iron wheels. The rest are all wooden and would not affect the current."

"Now, how about the safety of the public with an electric current running up and down the car tracks in the middle of a crowded street?"

The nearest approach to a proud, triumphant smile which had appeared there, then made its presence known on the Wizard's round, cheerful visage.

"A pressure," he said, a "little heavier than the one I use would make a horse lift his foot, so," and Mr. Edison raised one of his own feet about half an inch from the office floor, "but the pressure I do use a horse wouldn't feel at all, nor would a man. You see, I employ the heavy current with the low pressure. That is the whole secret of safety. The principle is this, that a stream of water 100 feet wide which falls a foot gives the same power as a stream one foot wide which falls a hundred feet. The wide stream is my way, the high fall some other people's, and the allowance of such pressures in public streets as some that are used is like letting a man place a boiler in a vault under a street and put on a thousand pounds of steam if he wants to do so. Electricity has developed too fast, you see, for the law to keep up with it. The whole question is one of expense. A low pressure trolley wire, for instance, requires four times as much copper as a high pressure one."

"Will the street car plant be expensive?"

"The system will be the cheapest known. The plant will not cost half as much as the cable and there will be no tearing up of the streets. Why, under pressure I could lay a mile of track for this system in a night. I never could see the use of taking possession of a street anyway. Why, when I laid the conduits for my incandescent light wires myself I would have all the work done at night and the street ready for use in the morning. When I turned the same work over to a contractor he would rip the street up and let it stay so."

"I think," said the Wizard, growing almost enthusiastic, "that I have really solved the great street car problem. Elevated railroads are too expensive for most communities, so is the cable for most streets of those communities. Overhead wires the people will have no more of. This is cheap, swift, and safe. In smaller cities one of its great advantages will be to double the traffic. The men who are now accustomed to lunch near their places of business will go home to their midday meals."

"And when will the system be put in operation?".

"Mr. Villard is attending to that. He will soon have a track for demonstration ready in the vicinity of New York."

Mr. Edison looked contentedly out of the windows. Then he changed the subject. "We have now orders for 100,000 tons of this iron ore which we extract from the stone of this abandoned mine—100,000 tons, and before we are in actual operation. There are millions of tons of ore here in these supposedly exhausted mines which our separator will get out."

* Article in New York *Herald*, Oct. 25, slightly condensed.

What Mr. Villard Thinks.

(*Telegram in Saturday's New York Evening Post.*)

SPOKANE, Wash., Oct. 24.—Henry Villard, who is making a tour of the Northwest, in an interview yesterday, expressed a belief that all trains of the Northern Pacific before long will be operated entirely by electric power.

The C. G. S. System.

In a contribution to *Nature*, Prof. John Perry writes: In new applications of physics, in electrical engineering, for example, the use of the C. G. S. system is not only easy, it requires a large amount of ingenuity in any engineer to calculate in any other than in C. G. S. units, unless, indeed, he ignores all the experimental determinations already made for him and tabulated in the C. G. S. system. And yet such ingenuity has already been exercised, and laborious investigations have been carried out by some electrical engineers, with the result that certain parts of electrical engineering are getting to be even more unscientific in the units employed than any part of mechanical engineering. In the subject of heat, we can ignore the steam engine constructor; we can say to him, "Go on using your wretched pounds per square inch and your foot pounds per minute, and we will go on using our dynes per square centimetre and our ergs per second, because we are nearly independent of one another;" but we can make no such speech to the electrical engineer. We physicists have to say to him that we rely upon him to make new discoveries, to state to us new problems; and if he give us information in vague units of his own we cannot tabulate it for general use, and if he does not state to us his problem in the usual language, we are unable to understand him, and we can be of no mutual use to each other. But when he says to us that our language is cumbrous, that he has ideas to express for which we have no words, when he uses, toward us, properly for one, that adjective "academic" which has been more misused than Shakespeare's word "occupy" the culprit and the judge change places. We can blame him if he invents unsystematic units, but not until we have given him the language and units that are correct. And in some particulars the electric engineer has the right to blame us. For example, any definition of unit electric current is so stupid that a multiplier or divisor of π or 4π enters quite unnecessarily into all electro-magnetic calculation. The engineer and experimenter care less than nothing for "magnetic susceptibility" or for "intensity of magnetization," or for "free magnetism;" these are, to him, mementos of the time of twelve years ago, when the inventor made bricks in Egypt, and the very cleverest mathematical electricians were only distinguished from other inventors by the greater magnitude of their blunders. Dr. Hopkinson and Mr. Kapp and Mr. Bosanquet have given us simple ways of dealing with practical problems, and some of these are now known to every apprentice of an electric engineering factory; but we know of no mathematical treatise in which they are recognized.

Gearless Motors at the Convention.

One of the most interesting single exhibits at the convention was the car displayed by the Short Electric Railway Company, and equipped with two of their 15-h. p. gearless motors. It was in service steadily throughout the convention, carrying heavy loads of passengers, and subjected at times to severe tests. The Short motor has already been described in these columns, but some details of its actual performance will be interesting.

Through the discretion and courtesy of the Short company the gearless car was equipped with voltmeter and ammeter for testing, and any one who cared to do so was free to inspect the readings of the instruments while the car was on the road. A considerable number did so, and every opportunity was given them to examine for themselves with the greatest thoroughness into the action of the machine. A good many elaborate readings of the power required were taken, and the universal verdict was that the motors performed better service than had been anticipated. The conditions of the tests were unfavorable in that the car was very seldom at liberty to run at the speed for which the motors were designed, and consequently the rheostat—itself a very convenient and efficient piece of apparatus—had to be in almost continual use, to the disadvantage of the operative efficiency.

Two things about the working of the car are especially striking. First of all, even after a considerable number of trips the motors are barely warm, heating in fact less than the old double reduction machines with which electricians have been so long familiar. The resistance of the motors is so low—only an ohm and a quarter for the two coupled in parallel—that this result might have been anticipated, but it was most strikingly evident to any one who cared to put his hand on the field or armature of the machine after a long run. In the second place, the absence of gearing enables the car to run so freely that even on very slight grades it would run down without the use of any current, while on the level, after a fair start, it would continue running quite without current for a considerable distance. The time during which current was supplied on the round trip was noticeably less than with the geared motors, although while running —especially at reduced speed or up grade—the current required was greater than with the other types. It is a pity that the motor did not have a chance on unobstructed track to show its full efficiency at normal speed, but even under conditions necessarily unfavorable its performance was very striking, and the Short company apparently felt no fear of the judgment passed even on those results, as was evidenced by their entire willingness to have any desired tests for which apparatus was available. It is very difficult for any motor, gearless or geared, to crawl through city streets efficiently, and the gearless type is at a special disavantage in this respect. Its best field is on comparatively level suburban roads running at rather high speeds, and for such service it is capable of giving excellent results. The absence of heating and the type of armature employed—with widely separated coils very thoroughly ventilated—give good reason for expecting small repair bills, and even in case of accident damage is easily repaired, as a coil can be rewound in a short time without removing the armature sleeve from the axle or doing anything more than clearing away the fields to obtain ready access to the commutator. The method of suspension employed reduces in a very marked degree the danger from shocks, and the cushioned driving spider enables the car to start, stop and reverse with great smoothness. The complete absence of noise is a marked advantage of this machine and one that will tell in its favor, especially in the free running through suburban and residence streets, for which it is best suited.

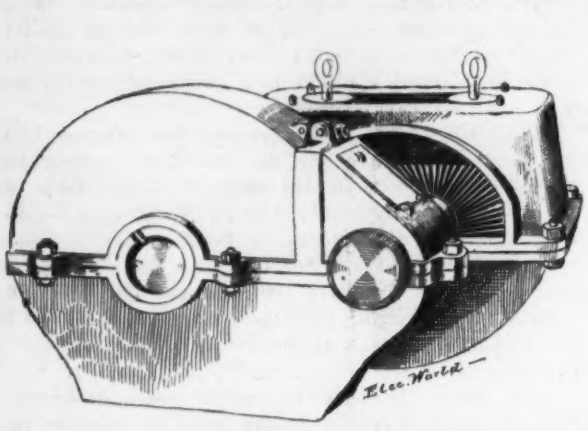
As mentioned elsewhere, the Westinghouse gearless car was on exhibition at the convention and ran admirably, but those most interested not only neglected to put testing instruments on the car but refused to allow tests to be made regarding the properties of the machines, the current consumed and other details that would interest practical street railway men who judge a motor by its results on regular trips and feel more or less distrust of laboratory tests. It is only fair to state that the Westinghouse machine is designed for a considerably greater normal speed than the Short motors, and hence in a city would work at even a greater disadvantage, but it is much to be regretted that an opportunity was not given for a comparison of the two systems.

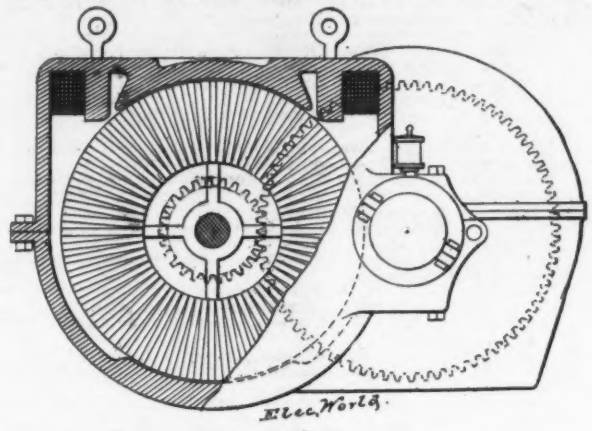
The Eickemeyer gearless motor, which has been very highly commended by those familiar with it, was unfortunately not represented at the convention.

The Thomson-Houston W. P. Railway Motor.

One of the most interesting exhibits at the Pittsburgh Street Railway Convention was a new slow speed railway motor of the Thomson-Houston company, of which the accompanying illustrations give an excellent idea. It has been in process of evolution for six months or more and has been worked up under the careful superintendence of Mr. Walter Knight. The new machine embodies some decidedly novel features and its excellent performance on the special car equipped with it was very favorably commented upon. It is known to the trade as the W. P. motor, which being interpreted means water proof, and it well deserves the name, because of the particularly complete iron-clad character of the field magnets.

Fig. 3 gives a perspective view of the motor, and from it





FIGS. 1 AND 2.—THOMSON-HOUSTON W. P. RAILWAY MOTOR.

the arrangement of the iron is at once obvious. Singularly enough, it is a two-pole machine, so arranged on the theory that the comparatively slight gain in weight efficiency that could be obtained with a multipolar type is more than offset by the increased complication of the windings. The only portions of the machine open to the outside air are exposed at the two oval openings at the ends of the armature shaft, and even these can be easily fitted with covers should such a course prove desirable. The whole magnetic circuit is composed of two castings bolted together and free to swing apart by a hinge allowing ready access to the armature. Fig. 1 is a rear view of the motor.

Fig. 2 gives an excellent idea of the internal arrangements. The armature itself is very nearly twenty inches in diameter, a very powerful Pacinotti ring nearly six inches on the face and of about the same depth. It is wound with

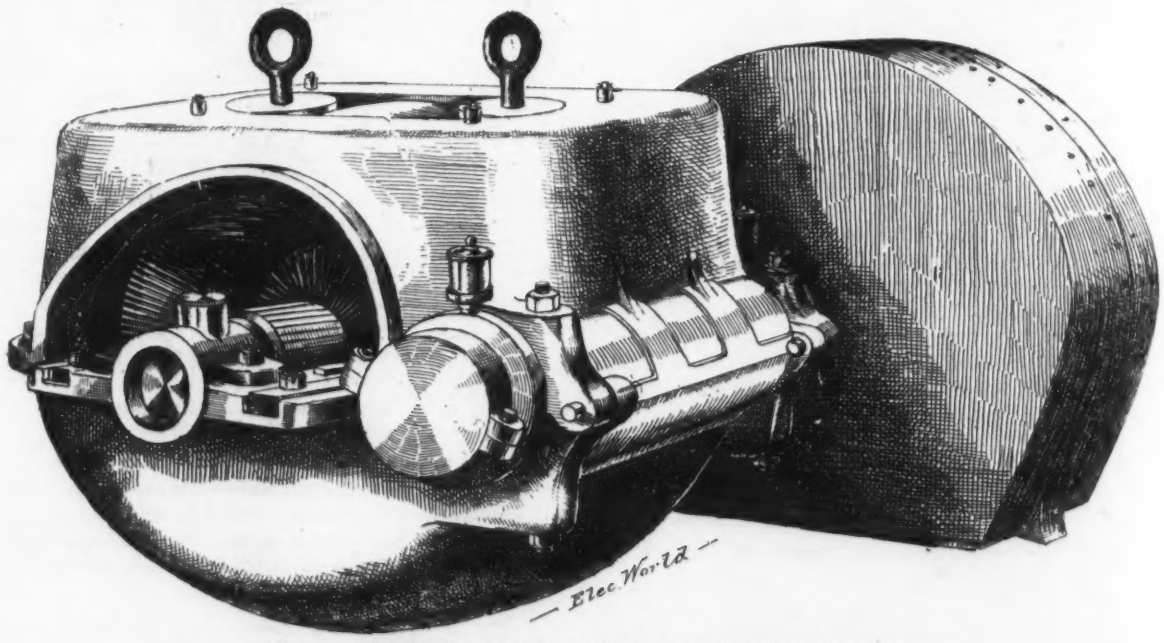


FIG. 3.—THOMSON-HOUSTON W. P. RAILWAY MOTOR.

comparatively coarse wire in sixty-four sections, with fourteen turns to the section. Each coil is tightly placed in the space between two of the projecting teeth, and about the interior space the separate coils are closely packed, leaving only sufficient room for the four-armed driving spider.

As will be seen, the armature takes up most of the full height of the machine, the pole pieces being but trifling projections and the requisite cross-section of iron being obtained by extending the poles to form a closely fitting iron box that appears in the exterior view. An unusual feature is the use of but a single magnetizing coil wound not directly about the upper pole piece but on the casing immediately surrounding it. The lower pole is but slightly raised and both pole pieces are of the greatest extent permissible with the dimensions of the machine. The use of a single magnetizing coil produces naturally an unbalanced field and a strong upward pull on the armature tending to relieve the pressure on the bearings. The iron-clad form, however, tends to distribute the lines of force so as to avoid the sparking and change of lead that might otherwise have to be feared. The single coil is wound with quite coarse wire and its position insures the maximum magnetic effect from the current.

The speed of the new motor is about the same as that of the older S. R. G. form, but its general working efficiency is somewhat better, owing not so much to a greater maximum of efficiency as to a better working curve—at both heavy and light loads. The brush holders are shown in the cut, and the slots in which they fit render their position evident. The brushes are of the ordinary carbon description and are readily accessible through the opening at the end of the shaft.

In operation the W. P. motor has been highly satisfactory. It runs with but trifling sparking and no heating to speak of, gives a very powerful torque, and is singularly free from liability to damage of the armature, for which its careful insulation and the Pacinotti form adopted are responsible. It is now being regularly manufactured at the Thomson-Houston works, and it is expected to take with great advantage the place in popular favor of the S. R. G. motor that has made so good a reputation for itself during the past summer. It is an interesting departure, both electrically and mechanically, and aside from its special features its general qualities of iron-clad field, gears running in oil, and the ease of access to the working parts will commend it to the practical street railway man.

Notes from the Electrical Department of the World's Fair.

The classification of the electrical department has been finally completed, and is now in the hands of the printers. It has been changed but slightly from the classification published some months ago and all changes are in the interest of the department.

The rules of the department governing exhibitors have been formulated under Chief Barrett's supervision by his assistant, Mr. Keller, and are now in the hands of the Director General for his approval.

The prospectus of the department has been completed, and this is also in the hands of the Director General for approval, from whom it will go to the Committee on Electricity. It contains all information that it is thought any one could desire, and will aid intending exhibitors in determining the probable cost of their exhibit.

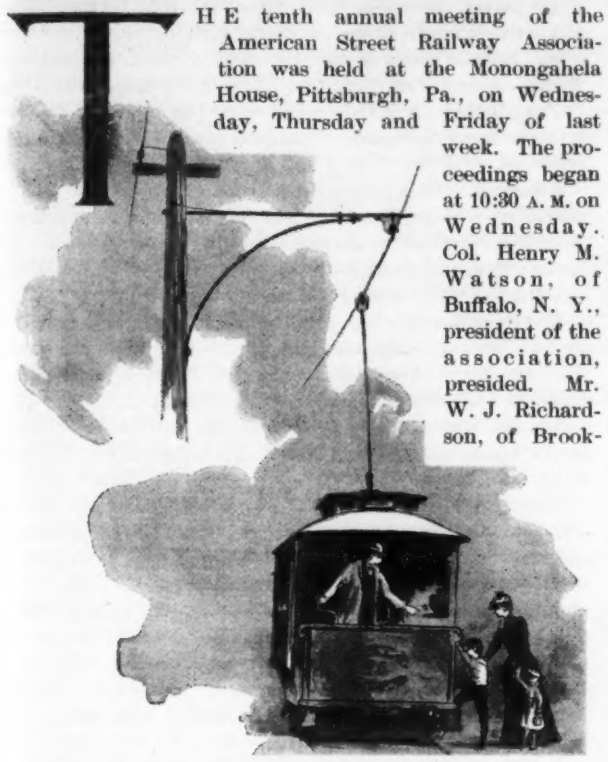
A recent letter from Chief Barrett's secretary, Mr. Hornsby, written in Frankfort, states that he left for Nuremburg on the 7th inst. to visit Schuckert & Co. From there he goes to Berlin, Cologne, Breslau, Dresden, Vienna, Budapest, Paris and London, to visit the works of the most prominent manufacturers met at the exposition. He has been sufficiently encouraged there to visit these places. He is already assured of extensive and complete exhibits. Hartman & Braun, of Rockenheim, assure him that they will make a magnificent display of their justly celebrated electrical instruments, etc. Dr. Hoepfner, the well known electro-chemist, of Giessen, was visited and promised a complete exhibit of his method of electrolytic extraction and purification of copper and other metals.

Frederick August Haselwander, so prominently connected with the Lauffen transmission scheme, promises to exhibit a wonderful street railway conduit, and has made in connection with Michael von Dolivo-Dobrowolsky, of the same enterprise, an assertion that they are ready to transmit 1,000 to 5,000 h. p. from Niagara to the World's Fair at a pressure of 50,000 volts over a bare wire. The Ganz people of Vienna talk of running an electric road from the exposition grounds to St. Louis, making the run every half hour.

A number of letters, telling the location of interesting historical apparatus and relics to be gathered in the historical section, have been received by Mr. E. E. Keller, and it is hoped that all persons having such apparatus or knowing of its existence will correspond with him.

Proceedings of the Pittsburgh Convention of the American Street Railway Association.

THE tenth annual meeting of the American Street Railway Association was held at the Monongahela House, Pittsburgh, Pa., on Wednesday, Thursday and Friday of last week. The proceedings began at 10:30 A. M. on Wednesday. Col. Henry M. Watson, of Buffalo, N. Y., president of the association, presided. Mr. W. J. Richardson, of Brooklyn, N. Y., the secretary, called the roll, and it was found that the following delegates were present:



ATTLEBORO, MASS.—C. F. Guild, president; H. M. Bogarto, George W. Mansfield, directors, Attleboro, North Attleboro & Wrentham Street Railway Company.

BALTIMORE, MD.—William A. House, Jr., general manager, Baltimore Traction Company.

BIRMINGHAM, CONN.—H. Holton, president, and B. W. Porter, superintendent, Derby Street Railway Company.

BRIDGEPORT, CONN.—F. Hurd, president, and T. B. Lasher, secretary and treasurer, Bridgeport Horse Railway Company.

BROCKTON, MASS.—Allston Burr, Brockton Street Railway Company.

BROOKLYN, N. Y.—William Richardson, president; William J. Richardson, secretary, and John G. Jenkins, director, Atlantic Avenue Street Railroad Company. John G. Jenkins, director, Broadway Railroad Company. D. F. Lewis, president; A. W. Dickie, superintendent, and M. G. Sterrett, Electrical Engineer, Brooklyn City Railroad Company.

BUFFALO, N. Y.—Henry M. Watson, president, and H. H. Littell, vice-president and general manager, Buffalo Railway Company.

CAMDEN, N. J.—William S. Scull, president; G. G. Browning, treasurer; J. J. Burleigh, electrician, and Samuel J. Fenner, superintendent, Camden Horse Railroad Company.

CHICAGO, ILL.—D. J. Kennedy, president, and A. H. Quaid, superintendent, Cicero & Proviso Street Railway Company. T. C. Pennington, treasurer, Chicago City Railway Company. Charles F. Nagel, superintendent, West Chicago Street Railroad Company.

CINCINNATI, O.—H. H. Littell, president, and H. M. Littell, general manager, Cincinnati Inclined Plane Railway Company. John Harris, superintendent, and George Bullock, director, Cincinnati Street Railway Company. Henry Martin, president, Mt. Auburn Railway Company; and E. F. Abbott, president, and T. M. Jenkins, superintendent, Covington & Cincinnati Street Railway Company.

COVINGTON, KY.—George Bullock, vice-president, and T. M. Jenkins, superintendent, South Covington & Cincinnati Street Railway Company.

CLEVELAND, O.—A. Everett, president; Charles W. Wason, vice-president; H. A. Everett, secretary and treasurer, and Edwin Duty, superintendent, East Cleveland Railroad Company. M. A. Hanna, president, and J. B. Hanna, secretary, Woodland Avenue & West Side Street Railway Company. H. J. Davis, secretary and treasurer, Brooklyn Street Railway Company. Charles Hathaway, president, Cleveland City Cable Railway Company; and A. D. Rogers, president, Columbus Consolidated Street Railway Company.

DALLAS, TEX.—Dallas Consolidated Railway Company.

DAYTON, O.—C. B. Clegg, president, Oakwood Street Railway Company.

DES MOINES, IA.—J. S. Polk, president; G. B. Hippee, secretary, Des Moines Street Railroad Company.

DENVER, COLO.—C. K. Durbin, superintendent, Denver Tramway Company.

DETROIT, MICH.—James H. Vhay, president; S. Schloss, vice-president; N. W. Goodwin, secretary, and E. S. Hineman, treasurer, Fort Wayne & Elmwood Railway Company. H. M. Campbell, attorney, and E. W. Cottrell, of Detroit Citizens' Street Railway Company.

DOVER, N. H.—William D. Sawyer, president; Henry W. Burgett, vice-president and treasurer, Union Street Railroad Company.

DULUTH, MINN.—F. S. Wardell, general manager, Duluth Street Railway Company.

ERIE, PA.—John C. Brady, vice-president, and J. F. Pfetch, general manager, Erie Electric Motor Company.

EASTON, PA.—Henry A. Sage, president, Easton, S. E. & W. E. Passenger Railway Company.

FINDLAY, O.—George B. Kerper, president, and Charles Smith, superintendent, Findlay Street Railway Company.

GALVESTON, TEX.—W. H. Sinclair, president, Galveston City Railway Company.

GRAND RAPIDS, MICH.—James R. Chapman, vice-president, and J. J. Odell, director, Consolidated Street Railway Company.

HAMILTON, ONT.—B. E. Charlton, president, and T. B. Griffith, secretary, Hamilton Street Railway Company.

HARTFORD, CONN.—E. S. Goodrich, president, Hartford & W. Horse Railway Company.

HOUSTON, TEX.—H. F. MacGregor, general manager, Houston City Street Railway Company.

INDIANAPOLIS, IND.—W. S. Jewell, superintendent, Citizens' Street Railway.

LEXINGTON, KY.—C. H. Stoll, president; W. J. Loughbridge, vice-president; R. H. Smith, superintendent, Passenger and Belt Railway Company.

LONDON, CAN.—V. Cronyn, president, and Thomas H. Smallman, director; London Street Railway.

LOUISVILLE, KY.—J. B. Speed, president, and T. J. Minary, general manager, Louisville Railway Company.

MANCHESTER, N. H.—Charles Williams, president; Chas. H. Bartlett, treasurer, and N. H. Walker, superintendent, Manchester Street Railway Company.

MILWAUKEE, WIS.—Henry C. Paine, vice-president; Geo. S. Jones, director, Milwaukee Street Railway Company.

MINNEAPOLIS, MINN.—Thomas Lowry, president, Minneapolis Street Railway Company.

NASHVILLE, TENN.—United Electric Railway Company.

NEWARK, N. J.—Thomas C. Barr, president; John Akerman, superintendent, and C. J. Field, electrical engineer, Newark Passenger Railway Company, Newark & South Orange Railroad Company.

NEWBURYPORT, MASS.—Charles Odell, president; Thomas H. Johnson and B. W. Russell, directors, Newburyport and Amesbury Horse Railroad Company; E. P. Shaw, Jr., general manager, Black Rock & Salisbury Railway.

NEW YORK, N. Y.—C. Densmore Wyman, vice-president, C. P., N. & E. Railroad Company. L. H. McIntire, engineer and manager, Harlem Bridge M. & F. Railway Company. William Richardson, acting president, D. D., E. B. and Railroad Company. Thomas H. McLean, secretary, Twenty-third Street Railroad Company. A. D. Field, president, Forty-second street and Grand Street Ferry Railway. D. B. Hasbrouck, secretary, Houston & West Pavonia Railway Company. W. H. Delany, director, North and East River Railroad. Milton S. Masson, secretary, Central Crosstown Railway Company.

LANCASTER, PA.—John A. Coyle, president, and W. M. Franklin, director, Lancaster Railway Company.

LAWRENCE, MASS.—N. E. Morton, superintendent, Merrimac V. H. Railway Company.

LOWELL, MASS.—P. F. Sullivan, secretary, Lowell City Railway Company.

MANSFIELD, O.—Clarke Rude, president, and Reid Carpenter, treasurer, Citizens' Electric Railway, Light and Power Company.

MCKEESPORT, PA.—J. C. Smith, president; E. P. Douglass, director, McKeesport and Reynoldton Passenger Railway Company.

NASHUA, N. H.—G. H. Knowles, general manager, and John A. Fisher, treasurer, Nashua Street Railway.

NEW BRUNSWICK, N. J.—G. M. Price, secretary, New Brunswick City Railway.

NORFOLK, VA.—James W. McCarrick, director, and N. G. Miller, director, Norfolk City Railroad Company.

OMAHA, Neb.—W. W. Marsh, treasurer; W. A. Smith, general manager, and Frank Marsh, cashier, Omaha Street Railway Company.

ORANGE, N. J.—Francis M. Eppley, president, Orange Cross-Town and B. Railway Company.

PATERSON, N. J.—H. Romaine, vice-president, and T. H. Bakewell, director, Paterson Railway Company.

PEORIA, Ill.—H. R. Woodward, vice-president, Central Railway Company.

PHILADELPHIA, PA.—Charles E. Ellis, president, and Thomas S. Manning, director, Citizens' Passenger Railway Company. E. J. Moore, president, Lombard and South Street Railway Company.

PETERSBURG, VA.—George Beadle, proprietor, Petersburg Street Railway Company.

PROVIDENCE, R. I.—W. H. Bronsdon, general superintendent, Union Railroad Company.

PHILADELPHIA, PA.—E. B. Edwards, president, Ridge Avenue Passenger Railway Company; Chas. D. Matlack, secretary, and Thos. D. Rulon, superintendent, car department, Second and Third Street Railway Company.

PITTSBURGH, PA.—John G. Holmes, president; C. M. Gormly, secretary, and J. E. Rugg, superintendent, Citizens' Traction Company. D. F. Henry, president; Wm. H. Graham, secretary; Wm. McC. Ramsey, electric superintendent, and Wm. A. Stone, solicitor, Federal Street and Pleasant Valley Passenger Railway Company. S. J. Macfarren, secretary and general manager, Schenley Park & Highlands Railway Company. George W. Elkins, president; Thomas S. Bigelow, vice-president, E. W. Davis, superintendent; J. W. Reed, auditor, Pittsburgh Traction Company. C. L. Magee, president, Duquesne Traction Company. George I. Whitney, president, Central Traction Company.

RALEIGH, N. C.—John C. George, president, Raleigh Street Railway Company.

READING, PA.—B. J. Owen, president, and Albert Welheimer, director, Reading City Passenger Railway Company.

ROCHESTER, N. Y.—C. K. Minary, general manager; H. Seller McKee, chairman executive committee, and Murray A. Verner, director, Rochester Railway Company.

SALT LAKE CITY, UTAH.—W. R. Reid, superintendent, Salt Lake City Railway Company.

SALEM, MASS.—Nathan E. Morton, superintendent, Naumkeag Street Railway Company.

SCRANTON, PA.—J. H. Vandsveer, general manager, and J. H. Richford, engineer, Scranton Street Railway Company.

SAN ANTONIO, TEX.—W. H. Weiss, president, San Antonio Street Railway Company.

SAVANNAH, GA.—J. H. Johnston, president; George Parsons, director, and Harry Parsons, engineer, City and Suburban Railway Company.

SIOUX CITY, IA.—James F. Peavey, president, Sioux City Street Railway Company.

SYRACUSE, N. Y.—A. Bartlett, superintendent, Consolidated Street Railway Company.

ST. PAUL, MINN.—Thomas Lowry, president, St. Paul City Railway Company.

ST. JOSEPH, MICH.—W. Worth Bean, president, St. Joseph & Benton Harbor Railway Company.

ST. LOUIS, MO.—Robert McCulloch, vice-president, Benton-Bellefontaine Railway Company, Cass Avenue and Fair Grounds Railway Company, Citizens' Railway Company, and general manager, St. Louis Railroad Company. James Adkins, secretary, and George W. Baumhoff, superintendent, Lindell Railway Company. John Mahony, vice-president, People's Railway Company. John Scullin, president, Union Depot Railway, D. R. Hamilton, president, and John B. Gault, director, St. Louis Railway Company.

SPRINGFIELD, MO.—Frank B. Smith, secretary, and A. H. Rogers, director, Metropolitan Railway Company.

TAUNTON, MASS.—George C. Morse, superintendent, Taunton Street Railway Company.

TERRE HAUTE, IND.—Willard Kidder, vice-president, and C. Kidder, director; Terre Haute Street Railway Company.

TOLEDO, O.—Albion E. Lang, vice-president, and Fred. H. Lincoln, electric engineer, Toledo Consolidated Street Railway Company. D. Robinson, Jr., president, J. J. Robinson, secretary, and G. B. Perkins, director, Toledo Electric Street Railway Co.

TORONTO, CAN.—George W. Kiely, president; William McKenzie, vice-president; James Gunn, secretary; C. C. Woodworth, treasurer, and H. H. Everett, general manager, Toronto Railway Company.

TRENTON, N. J.—P. E. Hurley, assistant superintendent; Jonathan H. Blackwell, director; F. W. Roebling and Chas. Y. Bambard, directors, City Railway Company. Lewis Perrine, Jr., president, and B. V. Hill, superintendent, Trenton Horse Railroad Company.

TROY, N. Y.—Charles Cleminshaw, general manager, and Charles H. Smith, superintendent, Troy & Lansingburgh Railway Company.

UTICA, N. Y.—O. T. Crosby, president, and W. E. Baker, vice-president, Utica Belt Line Railway Company.

WASHINGTON, D. C.—Wm. J. Stephenson, president, and R. F. Parker, treasurer, Columbia Railway Company. G. T. Dunloys, Washington and Georgetown Railway Company. W. J. Stephenson, president, and R. F. Parker, treasurer, Columbia Railway Company. George Truesdale, president, and F. H. Clark, director, Eckington & S. H. Railway Company.

WATERBURY, CONN.—Waterbury Street Railway Company.

WEST HAVEN, CONN.—Israel A. Kelsey, president, and Samuel A. Stevens, secretary and treasurer, New Haven & West Haven Horse Railroad Company.

WEST SUPERIOR, WIS.—S. T. Norvell, president, Douglass County Street Railway Company.

WILMINGTON, DEL.—Preston Lee, vice-president, and H. H. Archer, superintendent, Wilmington City Railway Company.

WILLIAMSPORT, PA.—H. R. Rhoads, president, and Wm. Haines, superintendent, Williamsport Passenger Railway Company.

WORCESTER, MASS.—J. B. Chapin, superintendent, Worcester Consolidated Street Railroad Company, Samuel Winslow, president; W. B. Ferguson, director, Worcester, Leicester & Spencer Railroad Company.

WHEELING, W. VA.—J. M. Sweeny, president, and W. E. Harrington, superintendent, Wheeling Railway Company.

YORK, PA.—William H. Larius, president; D. K. Trimmer and Frank Geise, directors, York Street Railway Company.

The opening address of President Watson was a thorough discussion of the present condition and prospects of the various methods of street railway traction and contained some valuable statistics. In the course of his address President Watson said:

"The most important matters to be discussed in the convention will be the problems which arise in the application of electricity to street railway traffic. It is a source of no little satisfaction to us to know that, in the development of the electric railway, America leads the world. Three years ago there were only 13 electrical roads in the United States; now there are over 400, and the advices from every part of the country indicate that before the close of the present year the number will be increased to 500. The capital now invested in American electric railways exceeds $75,000,000. "Horse sense" counts for but little in this age of rapid transit. We old dogs have been obliged to learn new tricks, and without the usual privilege of serving an apprenticeship. Our stables are being converted into power houses; the electrician has taken the place of the veterinary surgeon; our drivers are being educated as motor men, and most of us have horse cars for sale. It is well for us that at such a time, when a thousand unsettled questions perplex us, we can come together in this organization, with the memories of nine other gatherings still warm in our hearts, to exchange experiences, compare notes, and give to each other helpful information. Our cities and large towns are becoming as hungry for street railways as the people of the West are for steam roads, and the bulletins of the new census reports show that in 54 of the largest American cities the mileage was nearly doubled between the years of 1880 and 1889, the figures being 1,983 miles in 1880, and 3,150 miles in 1889.

"The following statistics have been compiled from returns made by street railway companies in the United States and Canada to the middle of September, and are believed to be as reliable as it is possible to make them:

Total number of miles	11,03
Number of miles operated by animal power	5,443
" " " " electricity	3,009
" " " " steam motors	1,918
" " " " cable	660
Total number of cars employed in street railway traffic	36,517
Number of cars operated by animal power	25,424
" " " " electricity	6,732
" " " " cable	3,317
" " " " steam motors	1,044
The number of horse employed	88,114
" " mules "	12,002
" " steam motors	200
Number of companies operating street railway lines	1,003
" " " by animal power	537
" " " " electricity	412
" " " " cable	54
" " engaged in building new lines, about	75

"It is interesting to note that since November, 1890, the number of horses employed on street railway lines has fallen from 116,795 to 88,114; that is, 28,681 in one year. At this rate, it will not take long to emancipate the horse from street railway business.

"According to the official figures taken from one of the street railway journals for the month of October, 1891, Philadelphia leads with 510 miles of single track; and after the Quaker City comes Chicago with 452 miles, New York with 289 miles, Brooklyn 285, Boston with 283, St. Louis 275, Baltimore 207, San Francisco 205, Cleveland 192, Cincinnati 180, Pittsburg 168, Kansas City 141, New Orleans 139, Louisville 132, Buffalo 110, Minneapolis 101, Los Angeles 99, Detroit 94, Birmingham (Ala.) 92, St. Paul, 90, Washington 85.

"The official figures of the census just completed show that in December, 1889, 476 cities and town possessed rapid transit facilities; and it is now difficult to find any town of 5,000 inhabitants without one or more street railways.

"Since the introduction of cable and electric transit, the government, in its wisdom, has found a new use for the street cars. Some of our lines have been elevated to the dignity of United States mail routes. The plan, in bold outlines, is to place on all the cars convenient little boxes for the collection of mail, which is taken up and sorted at some central point and the city letters sent to the sub stations, without any of the delays incident to the handling of the mails at the general post office. As an illustration of the workings of such a system there is on record a well authenticated instance of the travels of two letters, one of which was dropped into a letter box on a lamp-post in a large city, and the other sent from the same point at the same time to the general post office on an electric car. A comparison of the envelopes subsequently made shows that the last named letter actually reached Washington, 400 miles away, at almost the same time that the letter dropped into the box was received at the general post office, only two miles away. In the city, where all the cars come to a common centre, the plan seems most feasible, and companies who have not given this matter due consideration will do well to consult their local postal authorities at an early day."

The report of the Executive Committee, which followed, was a careful presentation of the work accomplished by the association in the past year and a review of the problems presented for the consideration of the members. The report contained this reference to the electrical features of the convention's work:

"Committees have been appointed to report on the following subjects, namely: 'A Perfect Electric Motor;' 'A Year's Progress of Cable Motive Power;' 'Public and State Treatment of Corporations, No. 3;' 'The Dependent—Overhead or Underground—System of Electric Motive Power,' and 'The Independent—Storage or Primary Battery—System of Electric Motive Power.' It will be seen that unusual prominence has been given to the subject of electricity; indeed, so much so that this meeting may be fairly called an 'Electric Meeting.' The committee considered that electricity had rightly earned the consideration which has been accorded it in the several subjects devoted to its consideration along different lines; and the development of the business during the current year has only tended to strengthen the committee in the wisdom of its allotment of so large a part of the time of this meeting to electrical consideration. The preparation of the reports covering the two distinctive systems—dependent and independent—were placed in the hands of men who were thoroughly competent to deal therewith, by reason of their intimate connection in each case with the respective systems. No limit whatever was placed upon the authors as to their treatment of the subjects, and it is believed that the consideration given thereto will be exhaustive. The gentleman to whom was referred the subject, 'A Perfect Electric Motor,' by reason of his long continued and varied experience with electric traction, as well as his extensive knowledge of the street railway business, was considered to be eminently qualified to tell this association what were the requirements necessary in a perfect electric motor."

At the conclusion of this report, Mr. H. A. Everett presented the following:

REPORT OF THE COMMITTEE ON A PERFECT STREET RAILWAY MOTOR.

For the past eight years the writer has been very intensely interested in the perfection of electric motors. The first experiments were made in the summer of 1883, but during the previous winter we had been carefully watching the operation of an electric system in the private premises of one of the large manufacturing companies, and had seen the motor operate under all conditions of weather—though, of course, experimentally. We had come to the conclusion that it was just the thing, and had hopes that it would revolutionize travel the world over. On application to the city government, we were given the right to build one and a half miles of railway, with an electric conduit. The troubles and vexations we experienced with the conduit are not covered by the title of my paper, and I will endeavor to confine myself to explaining the changes that were required in the motor.

The first fundamental error made by the electricians was in the idea of increasing the voltage in proportion to the number of cars run, which of course, would be impracticable in a system of any size, but we did not know that then. We got our experimental car, and quite frequently, for a few hours, it would work magnificently, giving a speed of 22 miles per hour with the utmost ease, and running forward or backward with one or two loaded trailers in fine shape. We were quite well satisfied with the experiment with the one car, but insisted on having a second and third car placed on the line before adopting it generally. We finally got the second car running, and were very much dispirited to find that the speed of both cars was immediately reduced to about four miles per hour. This result was, of course, very unfortunate for us. Returning to my subject, in starting in with the motors we tried wire rope transmission from the armature to a drum on the axle, but it did not work at all satisfactorily, the ropes oftentimes stretching too much. We then tried manila rope transmission, but that also had its weak points, and the change to friction gear also proved unsuccessful. After these various trials, the late Richard N. Allan requested us to allow him to gear it at his own expense with a system of cog gearing which he was quite sure would prove successful. We very gladly gave him permission to put in the gearing, and (this style of gearing has been practically adopted by all the prominent electrical companies in the country) after trying to operate this line for about a year and three months, we gave the matter up for the time being, believing that it was impracticable either to operate a conduit, or to operate by the system as suggested at that time, though never losing faith in the final outcome of electric propulsion. We examined a great many motors and traveled over a large part of the United States to observe tests made of storage batteries of various kinds, but we were not at all satisfied as to their successful practical operation, and, until we saw the road operating at Richmond with overhead wires, we had no desire to again enter into the matter of electrical propulsion, although it must be admitted that some of our people were willing to put in a system similar to the one at Scranton, even before the Richmond system was in operation. An electrical motor of three years ago should hardly be compared with the motors manufactured at the present time, and, on the other hand, a motor that is considered perfect, or nearly so now, might be considered old-fashioned and obsolete within a much shorter period. We have made several test of storage battery systems, and have watched with great interest the many tests made in that branch, and, candidly, we must admit that the practical successful application of storage batteries for street railway propulsion seems as far in the future as it did five years ago. Almost all street railway men admit that the storage system, if successful, would be the ideal system, and all hope for its ultimate achievement; and in this age of progress it would be very short-sighted and bigoted to say that it will never come.

All of the prominent companies are eager to perfect their motors in the matter of details, and have cheerfully cooperated with the practical men running electric roads to bring about the improvement of their machinery. All the well-known systems of the day have some special points of advantage, but these I will not refer to, as it is not within my province to do so.

The motors when first constructed were altogether too light, both mechanically and electrically, but these difficulties are being overcome very rapidly, as well as the serious difficulty of too rapid motion, which swelled the operating expenses very largely in maintaining the parts and replacing the gearing. The best motors manufactured hereafter will be the most simple in the matter of the construction of the parts, and at the same time not consuming too great a quantity of electricity, so that in addition to being simple they will also be economical. The principle of winding armatures is, of course, a pretty old one now, and each company is anxious to give its patrons the most efficient and best armature. I think it would be an improvement if in all machines made a better insulated wire were used in both armatures and fields. A more reliable and positive fuse wire application, one that would always burn out while still under the capacity of the motor, would also be a great improvement.

A great many corporations in operating motors do not appear to be willing to give them proper attention or inspection, with the result that weak points are very soon apparent; but this is in no way the fault of the manufacturer.

The writer expects within a very few years, as the motors are perfected and their armature speed reduced, to see a line of railway from New York to Chicago, run on the basis of not more than a two hour time table for the through trip, and giving a transportation rate considered impossible with the present motive power. A great diversity of opinion exists as to the proper size of motor cars, a good many companies holding to the principle that a very large car is desirable and practicable. From our experience in operating cars from 16 to 30 feet in length I am of the opinion that on routes having a small patronage where the earnings are under 20 cents per car mile run it is unwise and undesirable to have a car exceeding 21 feet in length inside, as it is much more economical to have trail cars when the traffic is heavy, rather than to be at the continuous daily expense of hauling a very large car of great weight.

I would again reiterate the fact that motors have been wonderfully perfected within the past year, and if as much progress is made during the coming year there can be very little to ask in perfecting a motor, although it is very desirable that the mechanical application should be more carefully looked after. I do not think it was the intention to have me criticise in any way the special weak points of any system, but simply to refer to the whole question in a general way. If you will pardon a short divergence from the subject, I will relate an incident which occurred last spring. A gentleman largely interested in street railways made the remark that in the city of New York they would never permit the use of electric motor cars if accompanied with unsightly overhead wires. I asked him if it was quite consistent that so much objection should be made to a system which required but one copper wire, not exceeding three eighths of an inch in diameter, with posts on either side of the street, 150 feet apart, with a diameter not greater than an ordinary hitching post, after allowing on the street that beautiful structure, "the New York Elevated Railway," with its perfect (?), odorless, smokeless, noiseless steam locomotives, and shutting out both light and air to the people on the street where the railway is operated. He candidly admitted that he did not know but that the elevated road was about as bad as the overhead wires.

To resume my subject, at the present time all of the prominent companies are devoting the time and intellects of their best men to the perfection of a gearless motor. They all now have the single reduction motor in the market, which is certainly a wonderful achievement in advance of the late countershaft machines, and which ought to make a splendid exhibit when compared in the matter of operating expenses. But I have noticed one matter which the electrical companies seemed to have entirely overlooked in the manufacture of their apparatus, and I must say that this failure is universal.

All of the prominent companies seem to have fallen into the same error, and seem to persistently and maliciously continue in their evil ways. I do not think that any one subject connected with electrical propulsion has received so much attention from the railways as this one, and with so little co-operation and assistance from the electric companies. I, of course, refer to the price of their equipment. It appears to me that the companies, instead of operating 4,000 motor cars, could be operating 40,000 within a very short time, if they would bring the price down to a reasonable figure so that all companies could afford to purchase an equipment. I think it would also be desirable if the electric companies would supply all the extra parts from their shops at a price allowing a reasonable margin for profit.

Before closing this paper, I desire to extend my sincere thanks to all the gentlemen connected with street railways who have so kindly given me the benefit of their experience on this subject.

In summing up my idea of a perfect street railway motor at the present time, I would say:

Taking the trolley wheel, pole and stand, I think it desirable to have a wheel that is capable of following the wire at any angle, with a trolley pole brittle enough to break should it become entangled in the wires, without pulling them down, and a trolley pole rigid enough to give good, steady pressure on trolley wire, and so constructed that when the car is in the car house or going under a low bridge, the pole could come very close to the roof of the car, also flexible enough to give good pressure when the trolley has to be 21 or 22 feet high at the railway crossings.

The car should have a lamp circuit, with plenty of lamps distributed properly.

The perfect motor ought to have, as hereinbefore suggested, a reliable fuse plug, that will invariably blow before injury is done to the machine.

Have on each car the best lightning arrester that can be secured in the market.

In coming to the motor proper, it is desirable to use a controlling switch that is easily operated and readily reversed, in case of accidents. The simpler the controlling device the better, and it should be constructed with a view to guard against any possible disarrangement of the parts, so that it will be reliable in all cases, both electrically and mechanically.

The rheostat should also be carefully looked after, and properly protected to keep it from injury, by reason of water, snow or dirt getting upon it. It should only be available in starting the car to avoid the lunge of a start, and should be so arranged as to be cut out as scon as the car is started, and give the entire efficiency of the motor proper.

The motor should be well protected in all its parts from any outside interference, so that in running along the street it will be impossible to pick up nails, wire or anything that would short circuit it, at the same time observing that a motor must be properly ventilated to keep it from heating while in use. The cover should be made so as to be easily removed.

I deem it very advisable to have an armature of a large diameter, making a small number of revolutions per minute, with the bearings made of extreme width with proper grease cups, and in such a condition that they can be readily re-babbited when slightly worn.

The diameter of the commutator should also be large, and to have the brushes easy of access is very desirable. The winding of the armature ought to be of the simplest kind, and the size of the wire and insulation of same should be carefully looked after. I think the insulation of wires in armatures is at present one of the weakest points in the motor.

The armature gears should have a wide face, and run in oil. The armature shaft ought to be of ample diameter, and there is nothing gained by having the keyway too small for the securing of the commutator to the shaft. The commutator should be carefully insulated, so that there will be no grounds between it and the case. The box in which this gear runs ought to be constructed of copper, or some light material that is somewhat flexible, so that if struck from the outside it will bend rather than break. The fields should also be wound with a wire of better insulation, and of ample size to take the current. Of course, in this particular, I do not intend that the wire of either the field or armature should be great enough to take more horse power than ought to be used by the machine. To my mind it is very desirable to have the armature in such a condition that it can be readily taken out from the machine and put in again.

One of the serious disadvantages to operators of electric roads is the expensive labor necessary in winding the armature and fields, also in regard to high priced mechanics who ought to be employed to attend to the machines. There is nothing gained in employing a cheap class of labor to handle an electric equipment, either as electricians, armature or field men or mechanics. This proposition is a self-evident truth, as can readily be observed in many roads now in operation.

At present, I think the single reduction motor is the nearest perfection of any on the market.

I think it very desirable that the electric companies should devote some time to the perfection of an electric brake to stop the car with the same power that runs it. This could be readily done and would be a satisfactory improvement.

Electric heaters are now used in quite a number of places and I think will prove quite satisfactory.

I have noticed electric signal bells on some of the cars, and they seem to work very well. For a dasher gong on a motor car I am in favor of a foot tread, as in testing an electric gong we found that our men used it altogether too freely.

I am in favor of an oil headlight, one that can be removed easily, so that in the event of a trolley being broken or anything happening to the electric part of the car, or a light is desired underneath the car, the oil headlight can be used to better advantage than the electric. There ought also to be one oil light in every car for the same purpose. There is no reason why an electric fare register cannot be made to work successfully.

The durability of the motor is a question which requires very careful attention. The single reduction motor, when properly looked after, ought to last for many years. We have had one in operation for over 10 months, and it appears to be in as good condition as when it first went on the road. The car should be of moderate size, constructed with all modern conveniences, but without fancy decorations or any unnecessary display.

The cars should be run on frequent headway and at all hours of the day and night, at as high a rate of speed as the civic authorities will permit. The noise of the motors has been very largely done away with, and by careful attention the old countershaft machines can be used until worn out by simply covering the gearing with an oil box, and by not attempting to run them too many miles without inspection.

DISCUSSION OF MR. EVERETT'S REPORT.

Mr. STEPHENSON, of Washington: I would like to get some opinion in regard to the comparative cost of operating electric and horse railways.

Mr. HENRY, of Pittsburgh: I have in my hand a copy of my last annual report. Our total cost, including conductors and motor men, all repairs, maintenance of way, general expenses and all other charges, amounted to 20.26 cents per mile. Separating this into strictly operating expenses and fixed charges, we have operating expense of 12.74 cents per car mile, and in comparing the same with the cost of operating the horse line, which was 10 cents per car mile, we must remember that we then paid but one man on a car, where we now pay four, or three cents a mile against 6.8 cents now. This increased cost per mile for conductors and motor men is a necessary adjunct of rapid transit, and is not peculiar to the system. Allowing for

this, we have a difference of 1.04 cents per car mile in favor of electricity as against animal power.

Mr. PEARSON, of Boston: Our road has about 350 cars equipped with electric motors. The expense of operation with horses is about 25 cents per car mile, including everything connected with the operation, fixed charges and track repairs. In Boston the cost of operation is quite high as compared with some other cities. You will find in many cities the cost of operation of horse cars is below 25 cents, but we pay a good price for labor on account of the running of our lines in the congested parts of the city, where we cannot get as much work out of a man as you can in other cities. This makes a greater cost of operation. The cost of operation with electric motors up to the present has been about 20 cents per car mile. The increased cost of operation in our city is also true to a great extent with electricity. We pay 25 cents a day more for motor men and electric car conductors that we do for horse conductors and drivers. That has been our experience up to this time; we save about 25 per cent. Our men are really expected to work ten hours a day but we really get anywhere from seven and a half to nine and a half hours a day. The amount of power consumed is considerably more on account of the slow speed with which the motor cars have to operate in the downtown sections of the city. There the streets are crowded with teams and cars, and I supppose that the cars run at an average of perhaps one or two miles an hour for a distance of from one-half to one mile, which, of course, decreases the profits very materially. We expect to get the cost of operation down to 16 or 17 cents per car mile. Another item of expense to us is the high cost of power, we having been obliged to hire power from an electric light company and pay a good price for it, of course much more than it would cost a street railway company if it had its own power house. As I said before, the saving of electric cars compared with the horse system is about 25 per cent.; being about 20 cents per car mile for the electric cars and 25 cents per car mile for horse cars.

Mr. RICHARDSON: I would like to ask Mr. Pearson what size of cars his company has operated in its electrical propulsion and what size he thinks, from his experience, would be the best and most economically operated, all things considered.

Mr. PEARSON: We began with a 16-foot motor car very similar to the old horse cars. We have changed from that to a long car, which is 26 or 28 feet long in the body and 35 feet over all. That is the car we have adopted as our standard. For our purpose we find a decided improvement in earnings and saving in operating expenses per passenger with the long car. I imagine that the conditions in Boston determine that for us, and in other cities it may be that the short car would be more profitable for operation. We find the long car earns a great deal more per car mile, and we have only the same number of men to operate it as with the short one. From our test we find that the amount of power consumed on a level track is very little more for the long car than with the short one; in fact, the weight which we have in the car seems to have little to do with the current consumed as long as the car is on a level track. From tests, we found that a long car empty, weighing, perhaps, 18,000 pounds, used a certain average amount of current, and that the same car loaded with 15,000 pounds of weight used very little additional power until we came to a grade. We have experimented in this matter, and could hardly tell from the reading which was the empty and which was the loaded car. That being the case it does not cost much more to operate long cars than short ones. Again, they carry nearly double the number of passengers, and do it with the same expense for conductors and drivers. Just how much more heavy cars will increase the track repairs, of course, we cannot tell at present. The last line that we have started has 26 long cars, and these are running at about 55 cents per car mile, compared with, perhaps, 30 or 35 cents per car mile. Our experience has been that the long cars are the best for our purpose.

Mr. SAGE: Where do you get your additional passengers?

Mr. PEARSON: They prefer to take our cars rather than the steam railroad. A great many people who formerly traveled on the steam road for short trips prefer to take our electric cars. The ride is pleasant and in the suburbs we go very quickly.

Mr. BALLARD, of San Antonio: In the city of San Antonio the entire line has been equipped within the last year. The total gross revenue of the old horse line, running regularly, was about $6,500 a month. We are now running at an average gross income of $12,000 a month with only an increase of the population of about 2,000. Our increased receipts are nearly 100 per cent.

Mr. WM. RICHARDSON: Will the gentleman kindly state how much the cost of operation in the aggregate has been increased?

Mr. BALLARD: The increase is only 12 per cent. Our total outlay for operating expenses in earning a revenue of $12,000 a month against $6,500 a month is only an increase of 12 per cent. I would also like the gentlemen to bear in mind that we have to pay $5.50 for every ton of coal that we burn.

WEDNESDAY EVENING SESSION.

The first business of the session was the reading of the committee's report on "A Year's Progress of Cable Motive Power." At its conclusion Mr. Mansfield read the

REPORT ON THE DEPENDENT—OVERHEAD OR UNDERGROUND—SYSTEM OF ELECTRIC MOTIVE POWER.

The title of my paper which I have the honor to present you is somewhat broad in its scope. The committee undoubtedly meant by their selection that all systems whereby electricity is transmitted by electric conductors or devices to the moving cars should be included under one head. A moment's thought will, I think, convince any one of the breadth of a paper under such a heading. I felt somewhat as if the committee had given me too much of an undertaking to cover in one paper.

In looking over the field, therefore, I concluded that as there had been a great many specific papers within a year or two upon this very subject, I must in a broad and general way treat of the various "dependent" systems as they are to-day. Having decided this, I prepared a series of questions and sent them to every electric railroad in the country using the overhead system. I also undertook to examine into all other methods whereby the electric current is directly transmitted to the moving car.

In treating of the "dependent system" I have arranged the various applications of electricity to railroading under four headings, or I might say into four methods: First, the underground; second, the surface; third, the overhead, and fourth, the storage battery. The first three are arranged in reference to the locality of the electric conductor, or transmitting devices. I am aware that one or two of these methods may in some particulars merge closely into each other, but I do not see that any more distinctive lines can be drawn, and will now proceed with the discussion.

FIRST. THE UNDERGROUND METHOD.

Under this heading I have classified all methods of conducting or transmitting electricity to the car by means of any conductors or devices placed underground. I might possibly divide into two classes: First, continuous bare conductors placed in an open slotted conduit, and second, all other devices of automatic character which enable the contact piece or device on the car to take its electric current from sectional bare conductor or from bare metallic points, automatically made alive. There have been in this country at least four practical experiments with the first class, several hundred thousand dollars have been expended in testing it, and thousands additional in perfecting it, particular attention being given to the protection and insulation of the bare conductor. In spite, however, of all this refinement and study practically nothing has been accomplished; and I have no hesitation in asserting that the continuous live conductor in an open slotted conduit is to-day a failure, and that it cannot be made a success throughout our cities of to-day, its fatal weakness being our inability to prevent the conduit from becoming filled with water, mud, etc. The time may come when our sewerage systems will be perfect enough to enable us to overcome this fatal weakness. To-day, however, they are not, and even an optimistic view puts this time a long way distant.

No large practical experiments have been made with this second class, but a large number of patents have been issued, and evidently there has been a great deal of careful thought and study bestowed upon it. I have seen a number of models and elaborate drawings in various cities of the country exemplifying this class. I, however, have no hesitancy in asserting that this class also will never prove a success, nor can it be made to work successfully throughout any of our cities to-day. The reason for this is obvious. It is immaterial whether the automatic devices prevent the sections or contact points from being alive all of the time or not, if the conduit is filled with water or mud, and the points are made alive just as the car passes, there is bound to be a momentary grounding from these points. In other words, a point made alive in water with the other side of the circuit grounded, is just about as dangerous and bad as if it remained alive. It is true that the grounding may not be as severe, but still it will occur, and with a large number of cars throughout the city moving at the same time, causing therefore a large number of points to be alive, if any number of points were grounded through water it would cause a tremendous loss upon the central power station, and in all probability a complete grounding or short circuiting of the entire system. Numerous ingenious schemes have been devised to overcome this fatal weakness. None, however, have ever been put to trial. I have seen many, yet to-day there is no hope in this direction.

Several of these devices are very interesting and worth mentioning. One inventor placed his bare conductor in a rubber tube made something like a hose pipe. Arranged upon the upper side of this tube are the contact points, which might be likened to rivets punched or tapped through the tubing. The contact wheel or device rolls along the top of this tube, and is sufficiently heavy as it proceeds to press the tube together so that the contact points or rivets come in contact with the conductor inside the tube. By this means the current is transmitted to the motors. Obviously, as the car proceeds, the tube behind the contact wheel springs back into its original position. Plainly, however, if the conduit was filled with water, there would be an inevitable grounding of the points made alive, with consequent trouble and disaster.

Another arrangement was to have inside the conduit a large elastic tube with a bare conductor inside, this tube to be slit along its upper side. Attached to the car is a plow with a contact device at its lower end inside the tube and in contact with the conductor. This plow moves along with the car and slides through the slit. With this arrangement it is apparent that if the conduit were filled with water it would run in just before and behind the plow. Should this occur, the old fatal trouble would be bound to follow. Furthermore it would be exceedingly difficult to arrange the tube sufficiently rigid in position to withstand the action of the plow, and the sides of the slit sufficiently tough to withstand the friction. The question of turnouts would also be serious and troublesome.

Another inventor arranged on each side of his conduit slot rubber flaps shod with steel and held together by means of springs. Attached to the car is the plow as usual. As the plow passes along in the conduit it presses back the flaps. The objection to this, is, of course, the liability of the water getting into the slit before and behind the plow. To obviate this, the inventor ingeniously suggested that the whole conduit be kept under an air pressure, which air pressure would be sufficient to blow the water out at any of these open places where it tended to run in. I do not consider that any of these plans can ever be successful. We now come to the

SECOND, OR SURFACE METHOD.

The inventions covered by this method are somewhat similar to those employed in the conduit system, only, in place of being in a conduit, they are placed upon the surface of the street. By far, however, the larger number of arrangements are based upon what might be called the "interval" or "point" system. Primarily this arrangement consists of an underground insulated conductor connected by means of taps to contact points on the surface of the ground, held in place by means of iron boxes, and insulated therefrom by means of rubber, wood, fibre or other similar substance. Upon the car is swung a long contact plate extending practically from one end to the other. This plate is carried close to the ground, and is arranged to touch the points as it passes along. It is plainly apparent that if these contact points are always alive, then every time the street is covered with water short circuits are inevitable. To overcome this, many automatic arrangements have been devised to cut these contact points into circuit by the car as it passes along. One inventor had electro-magnets on his car, which imparted their magnetism to the iron contact pins or points. These becoming magnetized would lift a little armature inside the iron casing, which in turn moved a switch and cut the iron contact points into circuit. Another inventor arranged a slot between his tracks, in which the plow passed. As this plow passed the contact points, it would tip a lever or some other automatic device, which would throw a switch and put the iron contact points into circuit. Obviously, all these arrangements have the same fatal weakness—a liability to ground or short circuits. I do not consider any of them practically possible. There is one more system which practically combines all these methods, and which obviates many of the objections. The inventor has a slot between his rails and boxes, with contact device within, placed at proper intervals. Upon his car is a plow which passes along through the slot, and also a long contact plate or arrangement extending its entire length. The operation of the invention is as follows: The plow as it passes through the slot strikes a lever placed in connection with each box, which lifts for a distance of six or eight inches above the ground a piston carrying the contact piece proper. This is made in the shape of a right angle hook placed within a vertically moving piston, and thoroughly insulated from it. As this is raised up, the long contact plate under the car passes beneath the hook and holds it up. The current is taken into the car as the plate slides under the live hook.

Naturally, as the car passes along, the hook slides off from the end of the contact bar and drops back into place. To protect this hook, or contact piece proper, it is covered with an extension of the cylinder, so that, as far as the street is concerned, the surface is perfectly smooth, and one sees nothing but a small round cover in the centre of each of these boxes. The contact hook is alive only when it is resting on the contact plate of the car. Certainly, in so far as getting rid of all the troubles due to the street being covered with water, this is successful. The fatal weakness whereby the contact points remain permanently on the street surface is obviated here by the contact point being practically lifted six or eight inches above the surface. In regard to the permanence and reliability of this system, I can say nothing, as no trials have been made. The inventor claims to have overcome every objection.

Summing up the general results of the underground and surface methods, it certainly looks as if we could not expect very much from them in the immediate future. Much perseverance and money must be expended before as practical and certain a method as our present overhead one is attained. We surely are all anxiously and hopefully waiting for it. In behalf of the struggling inventors and our common good, I beg that you, gentlemen, will expend all on the above two items you possibly can.

Our rival is the cable. It certainly does look as if for the enormous sums they expend in making their system feasible we ought, for an equal sum, to make ours perfect. Mechanically it is an assured success, but electrically it has not so proved.

Is it not possible for some bright inventor to devise a scheme whereby the insulation of the live parts can be maintained? This is the sum of all the difficulties. A simple transposition of parts and the problem may be solved. Picture the result! No wires overhead. A welcome boon to millions of pent up suffering people in the

great cities of our country; the almost complete annihilation of our rival, and electricity forever established as the great transportation agent throughout the length and breadth of our land. Personally, gentlemen, I have large holdings of a 10 per cent., cumulative, preferred hope, and I sincerely trust you all will subscribe liberally, if you have not already done so. We now come to the

THIRD, OR OVERHEAD METHOD.

It is, I suppose, somewhat conceited for me to suppose that I can give you practical gentlemen any information on this subject. I have had, however, somewhat extended experience, and many opportunities for observation. I also addressed to all of the electric street railroads throughout the country a circular letter, asking for certain detailed information. The results of my own experience and the summation of the answers to these questions I have the temerity to lay before you.

There are two general methods of operating the overhead system. One is by having a continuous trolley wire wherever the track runs, and the second is to have this trolley wire divided into sections. For towns and for suburban traffic the former is almost invariably adopted and carried out. Practice would seem to indicate that but little trouble is experienced, and that there is practically no advantage in dividing the trolley wire into sections, in fact, a disadvantage, since you lose its conductive capacity.

The sectional trolley wire surely must be used for all city work. It would be practically impossible to operate in Boston without proper divisions. It is, however, almost impossible to originally fix all of these divisions once for all, as the topography of the city, the grades, location of power-houses, routes, lines of traffic, etc., all have to be taken into consideration. It is bound to be a gradual growth to a large extent.

Obviously the methods of feeding the trolley wire vary with the method of arranging the trolley wire. With the first method mentioned (using a continuous trolley wire) the feeders are either extended from the station the entire length of the line, tapping into the line at intervals, or else separate feeders are run out from the station to certain predetermined distances, and there tapped into the trolley wire. When more than one feeder wire is needed, in either case a repetition of the scheme is carried out from feeder wire to feeder wire. There is little to choose between the two methods. Both are good.

With the second method (the divided trolley wire) there are two ways of accomplishing the feeding. First, to extend a feeder the entire length of the line and tap into the centre of each section of trolley wire; or second, to extend the feeder the entire length of the line and tap into both ends of each section. The advantages of the former are that in time of trouble a man has to run to only one box to cut out a section, or the whole arrangement could be made automatic by putting a fuse or mechanical circuit breaker in the box. The disadvantage is that you lose the value of the trolley wire as a conducting medium, which in the case of hard drawn copper wire is considerable.

In the latter method (tapping into the section at each end) obviously a man has to go to each end of the section to entirely cut out that section, and two sets of automatic devices would have to be arranged to operate in case of trouble. You have, however, the advantage of utilizing the trolley wire as a conductor.

It is undeniaoly true that the question of feeder wires is one of great importance and a difficult one to always economically solve for all conditions. The point, however, which the railroad corporations should watch above all others is that they have enough. I have visited many roads where I found that the larger part of the trouble which they were complaining of lay in the fact that they did not have either sufficient trolley wire or track feeders. Railroad officials are very apt to object to feeders, because of, first, their cost, and second, the placing of so many wires overhead, which is liable to bring them in conflict with the municipalities and the public. The question of having a sufficient number of feeders underground for the track is one which they can have no valid or reasonable excuse for. To illustrate how important a part the ground wires or ground plates play in a system, I would mention that not long ago I was told that in the city of Cambridge, (Mass.), the superintendent often telephoned to the electrician that he could not get sufficient current, and that his cars would not run well. The message would be transmitted to the proper official and he would hasten over. By the time he could get there, however, possibly an hour or two would elapse, and when he did arrive he would find everything working all right, the potential having increased. After a great deal of careful searching the trouble was found. One of the principal ground plates at the station had been thrown over the embankment into the Charles River. At times of very low tide this plate would become exposed, rendering valueless its functions as a ground plate. As soon as the ground plate was thrown farther out into the river, the trouble ceased.

I strongly recommend as many of these ground plates as it is possible to have, not only at the station, but also along the line; brooks, bog land, water pipes, everything should be utilized for this ground circuit wherever possible. The plates can be made of sheet copper or iron, preferably the latter, and should have a superficial area of several hundred square feet. The wire connecting them to the track should be of sufficient size and very solidly attached to the plate and the rails. The continuous supplementary wire should in all instances be employed, and the rails bonded at least once. In no instance do I think it necessary or wise to place the track feeders overhead. If this plan is adopted and carried out, and proper connections are made between the rails, I do not think the railroad companies will ever have any trouble with loss of power on their ground circuits.

Referring again to the overhead feeder system, I am strongly of the opinion that for large cities all feeders should be placed underground. The cities in which this underground work has been adopted are Buffalo, Minneapolis and St. Paul. I cry, all praise to the courage of these railway corporations!

I firmly believe that the trolley wire system is here to stay for many decades, and although I hope for a successful underground system, it may never come.

Under these conditions I contend that whenever any thing can be done to advance the interests of the overhead system it should be done. Now, will it not be materially assisting if you, when you go before your local municipal board and the public, petition for only the trolley wires, agreeing to place all other wires underground?

It is perfectly safe and sure. There is no reason whatever but the cost why all other wires should not be underground to-day. Science or practice has not demonstrated as yet that this can be done with the trolley wire.

For railway companies the question is one almost entirely of construction. The cables alone will cost in all probability less than the overhead wires. This construction work can be done simultaneously with the track reconstruction, for it is my experience that whenever a large city railway adopts electric power it is almost absolutely necessary to rebuild its tracks. Under these circumstances I doubt if the cost of the conduits or ducts would be more than a few thousand dollars additional per mile.

In regard to the overhead devices and material used, I can only urge the advice that the most substantial and perfect apparatus that can be secured be used. Too much care and attention cannot be bestowed upon these devices. It does not pay to put in some little cheap fifteen-cent arrangement, when for fifty or sixty cents a substantial reliable and standard device can be obtained. It is also well to consider the question of uniformity in the apparatus, The only part that is liable to deterioration is the insulating material. Make this, therefore, of a uniform pattern and arrange the various holders for its reception. With such a system nothing can fall, and the insulation is maintained easily and perfectly. It would be like renewing a glass insulator on a telegraph pole.

I come now to the discussion of the answers to the forty questions I asked by circular letter.

Out of the 400 and odd circulars I sent out, some, however, being duplicates, I succeeded in getting answers from 137 roads, operating 1,546 miles of trolley wire and 1,657 motor cars. Of this number 71 were Thomson-Houston and 66 Edison or miscellaneous. I wish very much I could have obtained answers to a greater proportion. I certainly wish to convey my sincere thanks to those who did answer, for I realize it must have taken time and sorely tried their patience. For the sake of convenience I have divided the various questions into the following topics: 1. Trolley wire. 2. Span and guard wires. 3. Feed wires. 4. Loads carried and conditions. 5. Tests. 6. Accidents. 7. Miscellaneous.

First. The trolley wire: Of the 137 roads 99 were using copper wire, 28 silicon bronze wire, eight were using both, and two were using phosphor bronze.

Of those using copper, one used No. 000; five, No. 00; three, No. 1; two, No. 2; one, No. 5 hard drawn copper; one used No. 0 soft drawn copper, making 13 in all, and leaving 86 as the number using No. 0 hard drawn copper wire.

Of the 28 using silicon bronze, 16 use No. 4; six, No. 2; one, No. 3; and the five remaining roads had combination, of two or more sizes.

Of the eight using both silicon bronze and hard drawn copper, six prefer the latter.

Out of all these 99 using copper not one dissents, but of the 28 using silicon bronze 11 advise copper. The proof is conclusively in favor of hard drawn copper wire and of the larger sizes, No. 0. B. & S. seeming to be the standard.

In regard to the wearing, the universal testimony is that it is exceedingly slight. What wearing is observable is found to be at the switches or on the curves.

Serious mistakes have been made in the past by using iron flanged trolley wheels. These cut the trolley wire badly. Everything should be done to throw all the wear on to the trolley wheels. These are much less expensive than wire, and not so hazardous for the public if they give out.

From my own information and knowledge I can say that the life of the trolley wire is much longer than I originally anticipated. The criterion is not the years that it has been up, but the number of times the trolley wheels have passed over it. It would seem that with the ordinary brass trolley wheel the wear was about .001 of an inch to the passage of 65,000 cars. This is at the rate of one in every six minutes, for 18 hours per day, for one year. With only this wear the life of the wire would certainly be 20 years, unless through some process of crystallization it became more brittle. I anticipate but very little trouble in this direction, but eternal vigilance is nevertheless neccessary. Undoubtedly, at curves and on switches the wear is somewhat greater. How much I cannot say.

The breaking of the trolley wire has been rare, the breaks occurring either at splices or switches, or were due to some extraneous cause, such as falling trees, telephone poles, or the catching of the trolley pole. One road reports a break as due to the striking of the trolley wire by a locomotive smoke stack. In no instance was any casualty reported, excepting in one case where a mule was killed.

Forty one roads have their trolley wires divided into sections, and considered it necessary and advisable. Analysis shows that these roads are in the largest cities or towns.

Regarding span wires, forty-nine report as using galvanized iron wire, fifty-five as galvanized steel, twenty as using galvanized iron cable and one as using copper wire. The sizes range from No. 0 to No. 14. Comparatively few breaks are reported and no casualties.

My own experience has led me to adopt No. 4 B. & S. soft galvanized iron wire. Whenever a long span or a curve is to be constructed I have had two or more of these wires twisted together into a cable.

I have found that a cable made of small wires is hard to joint, and it rusts much more quickly. Avoid joints, and use a ball fastener in attaching span wire to eyebolt. On the whole, however, I have concluded that iron is not the proper material to use in any shape. It will rust, and then your structure is weak. Pursuing my investigations into this matter nearly a year ago, I found that a certain special quality of silicon bronze wire was the best. Tests of this wire in comparison to iron showed the following results:

	Diam.	Breaking weight.	Breaking weight per sq. in.	Elongation in six feet.	Twists in six feet.
No. 1. silicon bronze...	.200	2,550	81,800	.8 per ct.	37.4
Galvanized iron.....	.205	1,720	52,000	7.8 per ct.	19

I am aware that the price of this wire is five or six times as great as that of the iron wire, but as the total sum in either case per mile is small, I strongly recommend it. Some of the wire has been in service on the West End road in Boston for nearly a year. It certainly will never rust out. Guard wires are universally condemned, but are put up as a compulsory protection from existing evils.

Third. The description of the various feeder systems are so vague I will not attempt to describe them. The average distance to which power is transmitted on these roads is about three miles. The greatest is 10.7 miles on the Tacoma & Steilacoom Railway, Tacoma, Wash. There are many, however, operating from eight to ten miles from the station.

Fourth. Loads and conditions: Under this heading I have included speeds, grades, number of tow cars hauled, passengers carried, etc. The average speed of all the roads is 8.7 miles per hour. The maximum is 30. The average grade is 6.7 per cent., and but 12 roads report as having none, or very small ones. The maximum grade is 13½ per cent., and this extends for 1,500 feet. The road suffering from such an infliction is in Amsterdam, N. Y. Thirteen roads report 10 per cent. or over. Nashville, Tenn., reports an 11½ per cent. grade for 1,300 feet, and Burlington, Ia., an eight and a half per cent. for 1,500 feet, while Wilmington, Del., reports a seven and a half per cent. for 3,000 feet.

The loads carried up these grades by two 15-h. p. motors are, to say the least, surprising. Amsterdam reports one motor car and 52 passengers. Nashville reports one motor car and 77 grown passengers. Burlington, one motor car and 75 passengers, and Wilmington, Del., reports one motor car towing a disabled motor car. Several roads report as towing one car with both full of passengers up eight and even nine per cent. grades, but for short distances. Auburn, N. Y., reports as having towed five cars, all loaded, with one motor car. The grades in this instance were slight In all these instances unquestionably the motors were exerting power considerably beyond their rated capacity. Trains carrying 350 passengers have been moved by two 15-h. p. motors; 200 passengers is an everyday occurrence. Surely this is approaching steam railroad practice. Such information is certainly useful to the electric manufacturing companies.

Fifth. Tests: Out of the total number of 137 roads heard from, only 32 report as having made any tests of either engines, dynamo or motors, and 53 upon the overhead work. Surely this is lamentable. There is nothing more essential to an electric railroad than a first-class voltmeter, ammeter, galvanometer, and, if possible, a wattmeter. Electric light, telegraph and telephone, and all other electric companies are supplied with necessary testing instruments, and in most instances a most rigid system is maintained. Every railroad should be continually testing its circuits, station and cars for leaks or grounds. By this means, and this means only, can they avoid trouble and consequent damage. Furthermore for the sake of economy these instruments should be used freely. Particularly is a wattmeter useful in a power station. I advise, urge and beseech every company to supply itself with these instruments, and to put them in the hands of a competent person, or if they can afford it, a thorough electrician.

Sixth. Accidents: I am happy to state that under this heading not one road reports as killed or even seriously injured an employé or passenger by the electric current, or falling trolley or span wire. Several report employés as receiving shocks, and one of a boy throwing a wire over the trolley wire and receiving the full potential of the current. None, however, were seriously injured. Several accidents are reported of collision and running over, but these cannot be entirely avoided, and are inherent in any system.

Miscellaneous: Under this heading I asked the opinion of the railroads as to the reliability, permanency and safety of the electric system. All but one report most emphati-

cally in its praise. I regret very much that this one perfers horses. Further evidence on this point is shown by the fact that 44 roads report as never having been stopped by any cause, 23 were forced to stop because of the steam plant, failure of water, floods or fire and 26 from electrical troubles, the main cause of these troubles being lightning. I consider this a very fair showing and feel confident that as the art advances these tie-ups will grow less and less, and finally become of rare occurrence.

Now, gentlemen, I have reviewed in rather a haphazard manner the dependent system.

I have said nothing in regard to the cost of operation. It is a difficult matter to handle and a delicate one to discuss. I feel that there has been already a sufficient number of statements published to enable any man to choose his own figure from. As there is to-day no generally accepted uniform system of accounting, it simply adds to the confusion to publish additional figures unless the most thorough detail is entered into. I take this opportunity to raise my voice and urge the adoption of some standard system.

Surely a basis of comparison with the independent system is useless, since there is nothing of any value whatever to be found pertaining to the cost of this system. In all other respects also have I avoided comparison with this system.

There is not to my knowledge to-day a single railroad corporation owning and operating storage batteries solely for what there is in them, nor do I believe there ever will be. It is now claimed that litigation has interfered with their development. This is absurd. With ideality written all over the system, do you think that the powerful corporations who have spent hundreds of thousands of dollars in experiment would finally abandon them and devote their energies to a system which they have had to spend almost an equal amount in introducing and exploiting, fighting their way inch by inch throughout the country? Had there been the slightest promise or intrinsic merit in the system it would ere this have been in every city in the land, litigation or no litigation. No, gentlemen, such sophistries are for the blind and unthinking. For years I have believed that the storage battery car should be relegated to where it belongs—a position with the air, gas and wind motors. I have no faith in them nor hope for them.

I have now briefly reviewed the dependent system, or, as I should have preferred to call it, the direct system. There are some grounds for hope in the direction of an underground or surface system. There is universal praise and encomiums sounding on every side for the overhead system. Six thousand seven hundred cars operated over 3,000 miles of track in the streets of full 300 of our towns and cities. surely testify to its merits and value. Of this number of towns and cities fully one-third have absolutely no other means of transportation. What objections there are are purely sentimental grounds. Given, a city with all wires underground, where would be the objection to iron poles and a single wire for each track? The rails themselves would be a thousand times more of a nuisance and dangerous. The benefits to come from its introduction are incalculable. In the words of Parnell, "Hold on, fight on. A magnificent future is before you." The wonderful and marvelous development of the past is not to stop, but inevitably must continue. Electric railroading, city, town and suburban, is here for our upbuilding and natural prosperity as surely as steam railroading was 50 years ago. There are equally great opportunities for fame and fortune with this new agent as with the old. Let there be no uncertainty, no hesitancy.

DISCUSSION OF MR. MANSFIELD'S REPORT.

Mr. MacGregor, of Houston: I would like information upon the matter of guard wires. Mr. Mansfield rather passed over the subject, stating that the guard wires are an abomination; but they are at present a legal necessity, and I would like to ascertain what has been found effective and simple and not a nuisance in the way of an obstruction in the street. Of course, additional wires are objectionable, but we must have them; and if he or any other gentleman can give me the information, I will be glad to have it.

Mr. Mansfield: When there is only one trolley wire to protect, we extend two light wires, about No. 14 on each side of the trolley wire, and about 18 inches above it and from 12 to 18 inches to each side. We suspend the longitudinal wires running parallel with the trolley wire upon an additional span wire. The additional span wire is insulated as perfectly as possible from the pole and from the trolley span wire and the longitudinal or guard wires proper are also insulated as far as possible from the span wire. In the case of two trolley wires, the general practice, so far as I have observed, is to stretch three guard wires, two of them outside the two trolley wires and one over the centre, all insulated perfectly from the other wires.

Mr. MacGregor: What do you consider their value as a protection to life and property?

Mr. Mansfield: I think they are of great value. I think it necessary to put them up. Most municipalities require them to be put up, and as long as you keep them perfectly insulated from the trolley wires any extraneous wire which may fall will strike them, instead of the trolley wire, and will dangle in the street as a dead wire, which may be removed.

Mr. MacGregor: Have your investigations led you to form an opinion as to the relative wear of the sliding and the rolling contact trolley?

Mr. Mansfield: No, sir. I believe only one road used a sliding contact trolley, and I think that has been abandoned.

Mr. Bickford, of Salem: I do not agree with Mr. Mansfield on the size of his guard wire; No. 14 is too small. Nothing short of No. 10 should be put up as a guard wire.

Mr. Ramsey, of Pittsburgh: I wish to ask Mr. Mansfield how long he considers a No. 14 iron guard wire will last without rusting, so that it will be liable to break; or Mr. Bickford how long a No. 14 wire will last, in an atmosphere like Pittsburgh for instance.

Mr. Mansfield: That is a troublesome question to answer; it might be several years.

Mr. Bickford: My idea in the use of a No. 10 wire is not so much as to its life as its additional strength in supporting fallen wires, especially when loaded with sleet in winter. On a portion of our lines we had broken telephone and telegraph wires on the guard wires for a long distance, and through it all we operated our cars without interruption, by using a No. 10 steel wire.

Mr. Littell, of Buffalo: I wish to ask the gentleman if he does not think it advisable to cut up his guard wire into sections, of say 1,000 or 1,500 feet, and put in circuit breakers; so that if any wire does fall, the current will not be carried a great distance.

Mr. Mansfield: I would advise it, and it is not done on many roads; the West End road in Boston, I believe, does so with the line every 500 feet.

Mr. Littell: It is done in Buffalo.

Mr. Wason, of Cleveland: Mr. McKinstry, who is manager of the telephone lines in Cleveland, informed me that his telephone wires in the centre of the city did not last much over a year; sometimes a year and a half. In our span wires we used galvanized steel wire, and at the end of a year and a half they were rusted so much that we dared not tighten them up. We have chemical works and oil works in Cleveland, and we do not know whether or not it is due to the gases that come from these factories. I believe our road was the first one to use the soft drawn copper for span wires. We use soft drawn No. 4 the same as for ground work. That has been up now over a year and there has been no perceptible elongation or stretching.

THURSDAY MORNING SESSION.

On assembling for the business of the third session a committee was appointed to nominate officers for the ensuing year and to select a place of meeting. Mr. C. D. Wyman then read the report of the committee on "Public and State Treatment of Corporations" as prepared by Hon. G. Hilton Scribner, of New York City. The next business was the reading by Mr. Knight Neftel of the report of the committee, of which the following is an abstract, on

THE INDEPENDENT—PRIMARY OR STORAGE BATTERY—SYSTEM OF ELECTRIC MOTIVE POWER.

Owing to litigation and a variety of causes, the storage battery system has made but little material progress in a commercial way during the past year.

The subject assigned me is "The Independent—Primary or Storage Battery—System of Electric Motive Power." So far, primary batteries have been applied only to the operation of the smallest stationary motors. Their application in the near future to traction may, I think, be entirely disregarded. Were it not a purely technical matter, it might be easily demonstrated, with our knowledge of electro-chemistry, that such an arrangement as an electric primary battery driving a car is an impossibility.

In view of the claims of certain inventors, I regret to be obliged to make so absolute a statement, but the results thus far have produced nothing of value.

The application of secondary or storage batteries to electrical traction has been accomplished in a number of cities with a varying amount of success.

Roads equipped by batteries have now been sufficiently long in operation to allow us to draw some conclusions as to the practical results obtained and what is possible in the near future.

The advantages which have been demonstrated on Madison avenue, in New York; Dubuque, Ia.; Washington, D. C., and elsewhere, may be summarized as follows:

First, the independent feature of the system. The cars being independent of each other are free from drawbacks of broken trolley wires, temporary stoppages at the power station, the grounding of one motor affecting other motors, and sudden and severe strains upon the machinery at the power station, such as frequently occur in direct systems; the absence of all street structures and repairs to the same, and the loss by grounds and leakages are also very considerable advantages both as to economy and operation.

Second, the comparatively small space required for the power station. Each car being provided with two or more sets of batteries the same can be charged at a uniform rate without undue strain on the machinery of the power station, and as it can be done more rapidly than the discharge required for the operation of the motors, a less amount of general machinery is necessary for a given amount of work.

Another and important advantage of the system is the low pressure of the current used to supply the motors and the consequent increased durability of the motor, and practically absolute safety to life from electrical shock.

It has been demonstrated also that the cars can be easily handled in the street, run at any desired speed, and reversed with far more safety to the armature of the motor than in the direct system. The increased weight requires simply more brake leverage.

The modern battery, improved in many of its details during the last year, is still an unknown quantity as to durability. There is the same doubt concerning this as there was at the time incandescent lamps were first introduced. At that time some phenomenal records were made by lamps grouped with other lamps. Similarly, some plates appear to be almost indestructible, while others, made practically in the same manner, deteriorate within a very short time. It is consequently very difficult as yet to exactly and fairly place a limit on the life of the positive plates. Speaking simply from observation of a large number of plates of various kinds, I am inclined to put the limit at about eight months, though it is claimed by some of the more prominent manufacturers—and undoubtedly it is true in special cases—that entire elements have lasted ten months, and even longer.

It must be remembered, however, that the jolting and handling to which these batteries are subjected in traction work increases the tendency to disintegrate, buckle and short circuit; and that the record for durability for this application can never be the same as for stationary work.

A serious inconvenience to the use of batteries in traction work is the necessary presence of the liquid in the jars. This causes the whole equipment to be somewhat cumbersome, and unless arranged with great care, and with a variety of devices lately designed, a source of considerable annoyance.

The connections between the plates, which formerly gave so much trouble by breaking off, have been perfected so as to prevent this difficulty, and the shape of the jars has been designed to prevent the spilling of the acid while the car is running. The car seats are now practically hermetically sealed, so that the escaping gases are not offensive to the passengers.

The handling of the batteries is an exceedingly important consideration. Many devices have been invented to render this easy and cheap. I have witnessed the changing of batteries in a car, one set being taken out and a charged set replaced by four men in the short space of three minutes. This is accomplished by electrical elevators, which move the batteries opposite the car, and upon the platforms of which the discharged elements are again charged.

The general conclusions which the year's experience and progress have afforded us an opportunity to make may be summarized as follows:

Storage battery cars are as yet applicable only to those roads which are practically level, where the direct system cannot be used, and where cable traction cannot be used; and applicable to these roads only at about the same cost as horse traction.

I feel justified in making this statement in view of the guarantees which some of the more prominent manufacturers of batteries are willing to enter into, and which practically insure the customer against loss due to deterioration of plates; leaving the question of the responsibility of the company the only one for him to look into.

DISCUSSION OF MR. NEFTEL'S REPORT.

Mr. Wm. Richardson: There must be some gentlemen present who have experimented with storage batteries, and I know we would all like to hear the result, and to get further information on this subject.

Mr. Baumhoff, of St. Louis: The company which I represent has experimented with the storage battery, and I must say that we have had no success. I believe our company was the second west of the Atlantic Ocean to undertake these experiments. We had two cars, each equipped with 120 cells, on an average grade of 2½ per cent., the steepest grade not over 3½ per cent. We were unable to get a greater mileage than from 18 to 22 miles out of each charge. The charging of the cars required from 8 to 12 hours. We found also that aside from leakage and the spilling of the liquid from the cells, the cells buckled and corroded, caused possibly by the acids. We expended a large sum of money in these experiments, but finally gave the matter up as a hopeless undertaking. The storage battery is certainly not a commercial success.

Mr. Neftel: I believe the experiments the gentleman refers to must have been made at least four years ago. In the past four years a great change has come over everything connected with the storage battery as regards the plates, and the shape has changed completely, so that the storage battery of to-day, as manufactured by the leading companies, is an entirely new thing.

I remember five years ago receiving a letter from the Thomson-Houston company, which I have preserved as a curiosity, asking me whether I thought electric traction would ever be successful and whether it would pay an electric light company to manufacture motors for electric traction. In the light of the developments made in the past in the general field of electric traction we should not cast discredit on the storage battery or throw it aside as a failure.

Mr. Barr, of Newark, N. J.: On this question of storage battery I only wish to refer to the road in Philadelphia of which Mr. Sullivan is president. The Lehigh Avenue Passenger Railway was built to operate storage battery cars. In May, 1890, the road started with six storage battery cars. In October, 1890, application was made to the Philadelphia Council for the use of the overhead system, claiming that unless they could use it they would have to abandon the road. The Council refused permission to the company to use the overhead wire, and on Jan. 1, 1891, the storage battery cars

were abandoned, and the road has since been operated by horse power.

Mr. VHAY, of Detroit: I represent a road which perhaps experimented with the storage battery system more than any other road in the country. The Woodward storage battery car was put on our road for about a year and a half. The system worked very well; the cars ran at the rate of about 12 or 14 miles an hour. The cost for coal was considerable, however—ten dollars a day—and it seemed to take from seven to ten hours to charge the plates, while it is not possible for the car to make over 35 miles a day. There were no grades, but some sharp curves. We thought that considering the expense and getting only 30 miles out of the battery, it was not much of a commercial success.

Mr. RICHARDSON: I should like to ask, if it takes from seven to ten hours to charge a battery, whether he will tell us how long it can operate in running thirty-five miles?

Mr. VHAY: I find that it takes just as long to charge it as it does to discharge it, if you call upon the car to do the work.

Mr. NEFTEL: I think it is a mistake to expect batteries to make a long run. If we have a perfected storage battery system, it will not be a system in which our cars will run 100 to 200 miles; but it will be a system in which each car will make one trip, then newly charged batteries will be put in the car. The batteries can be changed easily, and there is no earthly object in dragging them along for 30, 40 or 50 miles; it is taking along an unnecessary weight in lead.

Mr. E. A. SCOTT, of Philadelphia: I am the representative of the company that has put in two successful plants in Dubuque, Ia., and Washington, D. C. They are now operating them as a commercial success. The gentlemen connnected with those roads, if they are here, can probably tell you better than I what the result has been. I have seen the changing of the plates done in Dubuque in about 30 seconds, so that the question whether a storage battery car will run 100 miles without recharging, or 50 miles, does not become a matter of importance. As Mr. Neftel stated, there is no more necessity to run a battery 100 miles than there is of making a pair of horses pull a car that distance. You can work a pair of horses until they drop in their tracks, and you can do the same with a battery until it becomes exhausted, but there is no necessity in either case.

If you want to know whether any road can succeed, take the successful roads that are running at the present time. Go to Washington and examine the road there. and you will be delighted with the way the cars run. As to the length of time it takes to charge a storage battery, it has been correctly stated that it takes as long to charge it as it does to discharge it. We calculate to run about 20 or 25 miles before we make a change of the batteries, and if they are run in that way in a road where grades do not exist beyond five or six per cent. there is no trouble.

The question of how expensive the system is going to be is controlled by the question of how often you are going to renew the positive plates.

Mr. CLEMINSHAW: How many cars on the line in Washington?

Mr SCOTT: Six; and nine in Dubuque.

Mr. CLEMINSHAW: How long have they been running?

Mr. SCOTT: Since the early part of May in Dubuque and about three months in Washington. On certain portions of the road in Washington they are making 15 miles an hour; if the experience of everybody connected with the cars is to be believed they run regularly on their time, as regularly as any other system whether electric, cable or horse. I noticed in the paper that was read this morning that the question of comparative economy in running is stated to be about that of horses. We believe from what we know that it is considerably less than horses, although we have no figures to show. We believe that in about one year it can be run in competition so far as economy is concerned with any overhead system.

Mr. CLEMINSHAW: You say it takes as long to charge as to discharge?

Mr. SCOTT: I mean to say that when a car is run about 20 miles at the ordinary street car speed, it will take about two and one-half hours to charge the batteries for that 20 miles or more; but practice has shown us that it is very foolish to draw out the entire charge of the battery. The question of how long the battery will run before it will absolutely break down ought not to be considered for a moment, because it is very bad practice—that is the thing which destroys the cells. If the cells are properly used in this respect, the batteries will last a long time, for many months. I know of one plant in Philadelphia in the lighting service that has run five years without change.

Mr. MONTAGUE, of Yonkers: I have seen within three months a storage battery car, not the Edco, that will take 85 passengers on a 16-foot car and carry them up a grade of 10 per cent., and do it steadily and easily. It takes an hour and thirty minutes to charge the batteries. They do not allow the batteries, as a rule, to run more than 20 to 22 miles; but on Decoration Day of this year three cars ran respectively 42, 46 and 48 miles, and when they got back to the power house the engineer had gone home, and they remained outside all night. In the morning there was sufficient power left in the batteries to take the cars into the power house. It takes about 30 seconds to change the batteries. These cars run on level ground at a speed faster than most city governments will permit, and in mounting grades they go quite fast. On one occasion when a car was mounting a grade with 30 people in it, I got out and walked alongside of the car, and not until it had reached the top could I keep up with it. The grade was about five per cent.

Mr. RICHARDSON: How many cars are run?

Mr. MONTAGUE: Six cars.

Mr. RICHARDSON: I want to state what seems to me to be a fair inference from what these gentlemen have told us, and from my own investigations on the subject, and that is that the storage battery system seems only appropriate for roads running very few cars and on a headway of perhaps 10 or 15 minutes.

Mr. HOLMES, of New York: I am not a delegate to the convention, but it seems to me that the gentlemen do not state what the power is that is put into the batteries, and what is taken out. I think that point has not been covered. Assuming that we have one hundred horse power coming out of the generator in the station, it will not be denied that there is ten per cent. of loss on the line of the trolley in the transmission of the power to the car in the street. There is then a loss of about twenty-five per cent. in the motor, which reduces the net horse power developed by the motor under the car to about sixty-eight horse power for the one hundred at the station. Now we will take the storage batteries. Of the one hundred horse power developed in the station there is a loss, if I understand it aright, of nearly thirty per cent. in passing the current through the battery. Then there is a loss of twenty-five per cent. in the motor, the same as in the trolley system, so that in the power problem we have fifty-three per cent. in the battery and sixty-eight in the trolley system. The difference in the battery and the trolley is therefore vastly in favor of the latter.

Mr. SCOTT: I have not gone into the matter of figures; I can say, however, as to the amount of power that is required to run a storage battery car, I took for one week the mileage of the cars on the Dubuque road, and also measured at the dynamo the amount of power put into the batteries. I was enabled to get from the mileage of the cars the amount of horse power it took per car mile, and it was little less than one and one-half per car mile. If the gentleman can get a lower figure by the trolley system I should be glad to know how he does it.

Mr. HOLMES: We have got it down to one horse power.

Mr. SCOTT: I will say that the road has grades of over six per cent. If you will give us a level road I have no doubt we can do it with less power. I can tell you of one road where it averaged for six months in a commercial way eight-tenths of a horse power per car mile. I do not think you can get any lower than that.

Mr. CROSBY: I believe that much of this discussion is useless. No doubt the future has within it such possibilities as none of us, I think, should dare to measure to-day. I even go so far as to say that I believe in the future that it will be possible to propel a car by electricity without tying it by a string to the station. The trouble is we do not see how to do it at the present time. I do not think we can arrive at any satisfactory conclusion by continuing the discussion to-day, with all respect to the storage battery people. We must bear in mind that both systems are using the same power, applied differently. I do not believe the convention has the facts before it at this time to intelligently deal with this subject, and I think we can leave the matter for a time to those who are hard at work upon it.

Mr. WRENN, of Nashville: I think the remarks of Mr. Crosby are proper. It seems to me that we are drifting away a little from the real subject matter that should come before this convention. Before taking my seat it is my desire to offer a resolution that will carry the convention to another matter that deserves consideration.

Mr. RICHARDSON: As the gentleman says that the resolution refers to another subject, I wish to say that I differ from the remarks made by Mr. Crosby. We may not know all about the subject, as he evidently does, and it is for that reason that we wish to hear all we can. It is quite evident that, as I said before, the storage battery is suited at present only for small roads, with long headway. It would certainly not do for a road like the Third avenue in New York, where the headway is about one minute. I suppose also, with reference to roads that run like the Pleasant Valley, in this city, with four different lines, one of them starting four miles from its power station, and also like the road of which I am president, which has ten different lines, with eight distinct depots and stables, it would not be applicable. The advantage of the trolley system is that all these roads could be run from one central power station, as I am told by competent engineers. I wish while on my feet to express the intense disappointment I felt in visiting the Frankfort Electrical Exposition this year. There was not a single exhibit to indicate the progress of electric traction in America. Several American firms had exhibits of appliances for electric lighting, but so far as I could see there was nothing to indicate the great strides we have made in electric railway matters.

Mr. HOLMES: I wish to say that my only object has been to see where we can obtain the most power for a pound of coal. I do not see it in the storage battery.

Mr. Wrenn then offered the following resolution:

Practical information upon the character of engine that gives the best results in power plants for traction purposes would be of great benefit to the members of the association, and as there is much doubt on the question that may be removed by investigation into the practical experience of different companies having established active plants.

Resolved, therefore, That a committee of five be appointed which shall include the president and secretary, whose duty it shall be to obtain all available information upon this subject and report thereon. And in view of the fact that early information to the members of the association will be of great value, said committee shall ascertain the information, make a report and mail two printed copies thereof to each member on or before Feb. 1, 1892.

Mr. Littell, of Buffalo, then offered the following resolution:

Whereas, The American Street Railway Association having learned that the collection of the statistics of electrical railroads for the Eleventh United States Census has been transferred to the Division of Manufactures, and placed in charge of Mr. Allen R. Foote, special agent for the collection of statistics of the electrical industries, and

Whereas, The development of electric railroad construction and operation is of such recent date that nearly three times as many such roads are now in operation as in the census year, and

Whereas, Those interested in street railroads, in common with those in other branches of the electrical industries, regard a complete and accurate report by the United States government of all electrical statistics, and especially those pertaining to electric railroads, as of vital and far-reaching importance.

Be it Resolved,

1. That this association approves of the action of the Superintendent of the Census in placing the collection of the statistics of electric railroads in the Division of Manufactures, and in charge of Special Agent Allen R. Foote.

2. That it requests Superintendent Porter, of the Census Bureau, for the census year, to collect and report the complete statistics for electrical railroads down to the date of publication, and thus give to them their highest degree of value.

3. That a Committee on Census, composed of five members, be appointed by this association to represent it in an effort to secure ample provision and authority for a complete census of the electrical industries, and this association pledges itself to support all reasonable measures to that end.

THURSDAY AFTERNOON SESSION.

The secretary read a letter of regret from Willard A. Smith, chief superintendent of railway exhibits of the World's Columbian Exposition, who had arranged to be present and address the convention on the subject of the street railway exhibit, stating his inability to be present.

On motion of Mr. Richardson the matter was referred to the special World's Fair committee.

The next order of business was the reading by Mr. O. T. Crosby of the report of the committee on

STANDARDS IN ELECTRIC RAILWAY PRACTICE.

The object of this paper is to present some suggestions concerning a standard rating for electrical machinery, standard dimensions for parts for car apparatus, standard nomenclature for methods and parts, and standard method of keeping accounts.

I shall not go into any discussion of the value of standardizing methods and things, feeling confident that there if a very general appreciation of the value of uniformity in so far as it can be attained without sacrifice in other directions.

First, let us consider the rating of electrical machinery: Thus far it has been common to speak of a machine as a 15-h. p. or 25-h. p. motor, with scarcely any further suggestion of conditions under which it is supposed to operate. It must be borne in mind that an electrical motor, like any other machine, a man, for instance, is capable of performing work at widely varying rates and widely varying efficiencies, and with widely varying factors of safety with respect to indefinite continuance of such a rate of work. It should further be borne in mind that an electric motor in particular is known to do its maximum rate of work when its efficiency is only fifty per cent.; that is, if 20 h. p. represents the maximum rate of work, then 40 electric h. p. will be required to perform this work. A series motor such as is commonly used for railway work also must vary very widely in its speed while varying the quantity of work it performs per second. Now, this maximum quantity of work and the efficiency at which it is performed and the speed of the car connected with it, are all matters of importance when we endeavor to get a really serviceable idea of what the machine can do, that is, of how nearly it can meet the conditions required by the particular service to which we wish to put it.

Will it serve the purpose best if we rate the machine according to its maximum capacity when its efficiency is fifty per cent., or according to some lower capacity at half efficiency, and at some speed as nearly as possible that at which the motor must be run during the greater part of its time at service? Should we use the maximum rating, we have the advantage of knowing at once very nearly what is the limit of service which the motor can perform; but on the other hand we fail to be told by such rating what the capacity of the machine is when doing the average work of our service.

There is at present no conventional uniformity controlling either the manufacturer or purchaser of electrical machinery in regard to these matters, which can be determined only by the custom of the trade, as it may grow up through years of uncertainty or as it may be directed to more rapid maturity by the action of such an association as this. We shall not, of course, be able at once, by any such formal action as we might take, to bring everybody concerned to an immediate acceptance of such standards as we might adopt. Yet we will certainly go far toward hastening the time when some really definite and valuable information will be given to the purchaser when he is told that a motor is rated thus or so.

The first condition which in my opinion should be connected by implication with any rating whatever is this: That the machine in question shall be able to perform its rated work indefinitely and under any condition of atmospheric temperature. There is, of course, room for honest differences of opinion in regard to this point. It is well known that the maximum demands for power in street

railway service are not those which last for a considerable length of time. A certain manufacturer may thus argue to himself: "This machine which I am about to advertise is able to do 20 h. p. of work for half an hour when the atmospheric temperature is 90°. In my opinion this rate and time and temperature will not be exceeded in the conditions of regular service. Why, then, may I not call this a 20-h. p. motor? It is true if I were building it for stationary work, in which generally the load to be carried is much more constant, I should adopt a different rating." Another manufacturer produces, perhaps, a machine of identical capacity with the one just considered, but taking a more conservative view of the matter may feel it proper to give a rating in the neighborhood of 15 or 16 h. p., having in view that the machine shall be able to work at its normal capacity for an indefinite length of time, even if it were in service on the hottest day of the year known in the famous Fort Yuma. Machines of equal capacity are thus honestly put on the market at different ratings; and they may be in service on the same road without being actually subjected to such tests as would show their equality, the man who has rated high all the while getting credit for giving a more powerful piece of machinery than his competitor.

It would be possible to express this condition thus: That whatever the rate, it shall be possible to maintain that rate indefinitely under all conditions of atmospheric temperature by stating that the windings of the armature shall never show more than a given excess of heat over atmospheric temperature. A more general way of stating it, however, seems to me to serve the purpose quite as well.

There is again further room for honest difference of opinion in regard to the efficiency with which a motor can do its rated work. Suppose the manufacturer has produced a machine which can do its maximum work for an indefinite time without undue rise of temperature. There is to-day no custom of the trade distinctly understood which would prevent him from rating the machine by this maximum capacity. And, again, in stating that the machine is of 15 h. p. capacity, even if there be agreement concerning efficiency and durability, there might be disagreement of much importance in regard to the speed at which its work can be performed by the motor. If it has been so constructed that it can do 15 h. p. of work only at some armature speed corresponding to a linear speed of car either much above or much below the average speed of the car, then the formation and motor may both be of little value for street railway service. Indeed, the use of the term "horse power" then has necessarily this uncertainty in it: The total number of foot pounds per minute, namely, 33,000, may be made up in an infinite number of ways by an infinite number of combinations of feet of travel and pounds of pull. But for hour service we should have some known relation between these two.

It seems to me that that which the purchaser has in mind to obtain is such horizontal effort exerted at such a speed and at such an efficiency as will do the work in view. Now, the work in view varies very widely, and we cannot, therefore, obtain a convenient rating which will express this relation throughout the range of the total capacity of the motor. We may, however, select some particular conditions, say those approaching as nearly as possible to the average, and tell by a method of rating, which I will propose, what the machine can do for such condition.

Let us first consider the speed at which it is desirable to know the capacity of the motor. I think 10 miles per hour is not far from the speed at which cars will be found most frequently running. If, then, we state concerning a motor that it can develop so much horizontal effort at that speed, we at once have a pretty close approximation as to what load of a car and passengers it can handle at that speed, since we know that 25 pounds per ton is a fair approximation to the average traction co-efficient. Suppose, then, we are told that a motor can produce a horizontal effort of 500 pounds at 10 miles an hour; it is then a quick inference that a car weighing 20 tons can be carried by such a motor at the rate of 10 miles per hour on a level. We may then conveniently call this motor a "500 x 10."

If we further desire to get an approximate idea of what it will cost to do this work with a particular motor, we should know something of its efficiency. This can be conveniently expressed by adding another dimension. Thus, say the motor is "500 x 10 x 60." The "60" indicates the efficiency percentage with which electrical energy from the line is transmitted into mechanical energy and horizontal effort applied to the car.

It may, of course, at once be objected that such a method does not distinguish between efficiency of motor proper and the efficiency of its gearing. For a great many reasons this is not very objectionable. We buy the motor with its gearing, and I can see no particular reason why the manufacturer should not get the benefit or the blame of the good or bad gearing which he may use with his efficient or inefficient motor. Furthermore, in the single reduction motors now so widely used for ordinary street railway work, the loss by gearing transmission is very small, and probably not widely variant as between the different manufacturers. And again, in whatever high speed work which it may be feasible to do by gearless motors the question of the efficiency or the inefficiency of the gear is eliminated.

Again, it may be objected that such a method supposes uniform diameter of wheel, which must be known to the manufacturer in order that he may calculate what his motor is doing for a given car speed. Should there be no considerable variation from the 30-inch wheel now so largely used, such a diameter might be taken for granted as having entered the calculation; and if a different wheel, say 33 inch, becomes general, then that diameter may be assumed in the rating. I am not sure that the *most frequent* speed, supposed above to be 10 miles per hour, is that which should enter into the service rating. It may be best to assume some lower speed at which the work is considerably heavier, and concerning the performance of which the purchaser is most doubtful.

These particular points need further consideration than it has been possible for me to give them in the limited time of the preparation of this paper; and, indeed, I shall propose at the proper time that the whole matter of standards, which I endeavor here to treat only suggestively, shall be referred to a standardizing committee of this association.

In using such a method of rating as is here suggested, it may be well to leave the selection of conditions which he prefers to express to the manufacturer, who, of course, must in turn always be ready to express the performances of his motor for other conditions of speed and efficiency which may seem important to the purchaser. The important point is that expression shall be given to the *horizontal effort* and *speed* at which it is developed, and to the *efficiency* of development.

It would, of course, in any such rating, be assumed that the machine is working under a pressure of 450 volts, which is not far from that found on most of the lines throughout this country. In the necessary regulation to which these motors are subjected, a part of this pressure is practically applied to some resistance, external or internal, with respect to the motor; but I can see no convenient way of taking this into account in determining upon a rating. Indeed, the action of a series motor in street railway service is very complex, and it is much more difficult than sometimes supposed to determine upon a rating which shall give the greatest amount of valuable information. The very difficulty, however, is warrant for approaching the subject seriously and industriously.

I think it useless to attempt any change in the rating of dynamos. Their work is so much more regular than the work of a motor that the present rating in horse power or watts seems to answer the purpose fairly well. Nor has it occurred to me as advisable to extend this rating of watts to motors, as it will be a matter of difficulty to introduce a comparatively unfamiliar term and apply it to a machine whose capacity must constantly be talked about, and which, as above stated, works under very complex conditions.

Second. I feel that the time has now come when some one of the physical dimensions of electric cars may, with benefit to all, be standardized. As to how far standardization should go, committees of this association can best determine. The guiding principle it seems to me should be this: That standardization of parts should be so directed as not to interfere with the progress of invention. Bearing this in mind, may we not at this stage of development have a standard axle diameter for cars of a given weight? Also standard key weights for gears? And while there is some uncertainty in my mind on this point, may we not have a standard gearing? It of course involves uniformity in the reduction ratio between speed of the armature and speed of the car. There is, however, now no very great difference in this respect, and the possibility of uniformity is at least worth considering.

Coming to trolley apparatus, we might have uniform poles, pole sockets, and uniform diameter of pole at the butt; also uniform length of pole and uniform diameter of trolley wheel.

It may be possible to go further into this standardization of dimensions of parts of the truck which are not directly connected with the electric apparatus. I think it best, however, to leave that to those more familiar with truck manufacture.

It will be seen that the suggested number of standard dimensions in electrical apparatus, which thus far seems possible, is not large. Yet certainly uniformity of axle diameter and key weights alone would be found of much value to all interested in the business. Should this association adopt such standards it is of course understood that any manufacturer who thinks he has good reason to vary from them will do so, presenting to the trade his justification for such action. It seems, however, beyond question that a number of these points, in which there is no mystery whatever, may just as well be determined by the direct users of apparatus as by the designers, and may thus be determined once for all.

Third. In regard to standardizing nomenclature, the object is to save what may be called "lost motion" in the verbal and written correspondence incident to our business. The importance of some such effort was emphasized to me some time ago when, on reading a carefully drawn set of instructions to linemen prepared by an engineer of the Thomson-Houston Electric Company, I could see that those instructions would scarcely be intelligible to a man whose experience had been confined to the material of another company, say that of the Edison company, although the things talked about might be entirely familiar to him. Besides causing annoying repetition and much explanation between men really understanding very well the thing in question, this uncertainty of nomenclature may at times stand seriously in the way of the proper interpretation of written contracts, or of orders received by dealers.

While the adoption of a set of definitions by this association would in no sense be binding, it would yet tend to make definite that which is now indefinite. As a basis upon which some further and better work in this direction should be done, I give herewith a table showing list of proposed terms, with various terms heretofore used as equivalents, and definitions properly limiting the proposed terms. In some cases when there has been satisfactory uniformity, no equivalents are given, but definitions are suggested. The list can, with benefit, be considerably extended.

NOMENCLATURE OF ELECTRIC RAILWAY TERMS.

Generator.—(Generator, dynamo.) Machine in which the electric current is generated.

Motor.—(Motor.) Machine in which the electric current is transformed into mechanical power.

Frame.—(Frame.) Iron body of machine, including pole pieces and standards or side arms, if any, but not including base plates and bearings.

Standards.—(Standard bracket.) Supports of the bearings of generator.

Side Arms.—(Side arms, check pieces, armature bracket.) Supports of bearings of railway motors.

Pole Pieces.—(Pole pieces.) That part of frame from whose surface lines of force may pass directly to the armature.

Field Coil.—(Field coil, spool.) Coils of wire wound on frame in such a way that a current passing through these coils makes magnets of the frame and pole pieces.

Brush Holder.—Device for holding the brushes in contact with the commutator, including the insulation used in its support.

Rocker Arm.—(Yoke, rocker arm.) Device for holding brush holders in position on commutator while attaching it directly or indirectly to the frame.

Fuse.—(Fuse, fusible plug.) A metal device for opening circuit when the current becomes abnormally large, the soft metal being melted by a current of fixed quantity.

Switch.—A device for closing or opening a circuit at one or more points.

Rheostat.—(Resistance box, rheostat.) Wire or other material suitably protected and conveniently arranged to be introduced in more or less proportion into a circuit.

Trolley.—(Trolley contact bar.) A device used to transmit the electric current from the overhead wires to the cars, consisting usually of a

Trolley Wheel.—A small metal wheel making rolling contact with the overhead wire.

Trolley Fork.—Mechanically connecting trolley wheel to

Trolley Pole.—Supporting the trolley fork and wheel and resting in a socket, which is part of the trolley base frame.

Trolley Wire.—Wire from which the trolley wheel directly receives current.

Trolley Frog.—(Frog, overhead switch, trolley switch.) A device used to fasten or hold together the trolley wires at a point where the trolley wire branches, and to guide, ordinarily, automatically the trolley wheel along the wire over the track taken by the car.

Trolley Frog.—(Standard frog.) A frog designed for use at a point where two branch lines make equal convergent angles with the main line.

Right Hand Trolley Frog.—A trolley frog designed for use at a point where a branch trolley wire leaves the main line to the right in the going direction.

Three Way Trolley Frog.—A trolley frog for use at a point where the line branches in three directions.

Draw Bridge Cross Over.—A device permitting the easy passage of a trolley wheel from one to the other of two adjacent wires in a continuous direction.

Trolley Crossing.—(Crossing frog, cross over.) A device placed at the crossing of two trolley wires, by which the trolley wheel running on one wire may cross the other; the device also holding the two trolley wires together.

Insulated Trolley Crossing.—A device placed at the crossing of two trolley wires, by which the two wires are insulated from each other and by which the trolley wheel running on one line may cross the other.

Hanger.—(Line insulator, line suspension, trolley insulator.) A device for supporting and insulating the trolley wire.

Straight Line Hanger.—The hanger used on a straight line and supported from a span wire, the strain on same being essentially vertical.

Single Curve Hanger.—The hanger supported by a lateral strain in one direction and, ordinarily, on single track curves, except at ends and the inside curve of double track.

Double Curve Hanger.—The hanger supported by lateral strain in opposite directions, used ordinarily at ends of both single and double curves and at intermediate points, and on double track curves.

Feeder Clamp.—Clamp with a device by which a feed wire may be connected to the trolley wire.

Feeder.—A wire usually insulated, used for transmitting current from the power station to the mains or the trolley wire descent.

Mains.—Wires usually insulated, serving for the distributing of current from the feeders to the trolley wire through tap wires.

Tap Wires.—Wires to convey current from feeders or mains at the pole to a near point of the trolley wire.

Trolley Section.—A length of one trolley wire with or without branches, but continuous electrically.

Line Section.—A part of the overhead conducting system

so insulated from other parts as to permit the supply of power to be separately controlled.

Section Box.—A box containing section switches and fuses used for control of a trolley section or line section.

Fourth. In regard to standard methods of keeping accounts, I am permitted to present herewith information prepared by Mr. W. E. Baker, of the Thomson-Houston Electric Company, long in charge of their work of maintaining motors and lines for the West End Street Railway Company. Whether or not this association should take any action, such as recommending one or another method of keeping accounts, I feel sure that Mr. Baker's suggestions will be of value to those who will consult them. There is no special reason why the association should act with a view to obtaining standards in this respect, save that it will certainly facilitate in a great measure the obtaining of reliable statistics. Any one who will endeavor, as I have recently done, to get together a considerable volume of actual, reliable data on the operation of street railways, will be convinced that much remains to be done in this respect. Of the value of such garnered information I think there can be no doubt; and I am quite satisfied that this association will find itself thoroughly repaid for any efforts it may make toward accumulation of street railway statistics. Mr. Baker writes as follows under the title of "Accounts and Organization of Electric Street Railways:"

In presenting this paper, it is not offered as a treatise covering the ground of a rather pretentious title. There are many excellent and extensive works on railroad accounts in existence which ably discuss this large and important question in all its general aspects, and which apply as well to electric and to steam roads. This paper is offered rather from the standpoint of the superintendent or manager than the auditor, and in the hope only that it will prove a practical aid to the keeping of expense accounts of electric railways of about the extent and organization of the average of those at present in existence, although it is believed that the principles herein outlined are correct, and their extension to a road of any size is only a matter of increasing the details.

It is also hoped that some of the blanks and forms for reports furnished herewith will be an aid to some who, the author knows, have found some trouble in this direction.

From the superintendent or manager's point of view, the matter to be arrived at is to have presented to him in a concise and correct form such a statement of the operating expenses as will enable him, by careful study of the figures, to reduce expenses, to compare the operation of his road with that of others, and in general to enable him to exercise such care and watchfulness over the outgo and income as will render the enterprise a commercial success. The price to be paid for the success of an electric road is eternal vigilance and "a stitch in time."

The first and most important matter in the expense accounts is the classification or division of expenses, and the second practical matter is how to separate into these divisions the expenses without too much detail or clerical labor. For this purpose a manual should be carefully prepared.

In this manual there should appear four general divisions of expenses, namely: General expense, transportation expense, maintenance of way and buildings, and maintenance of equipment. Under these are sub-divisions, and under each are clearly expressed the proper labor or material to be charged to them.

Statements are frequently seen about as follows:

Motive power at so much per mile; car repair at so much per mile; and frequently conductors' and motor men's wages, being a very large single item, appears by itself, and the statement winds up with "other expenses" at so much per car mile.

Now unless it is clearly understood what is included in the term "motive power," or the term "car repairs," or the term "other expenses," such statements are apt to be very misleading.

Does "motive power" include the power house expenses only? It may or may not. Does "car repairs" include the repairs on the car bodies only, or the repairs also on the motors? It is clearly necessary to have these matters defined and in the manual before referred to all this should appear in detail.

If, then, the classification in this manual is followed, and a statement is presented that general expenses, transportation expenses, maintenance of way and building expenses, and maintenance of equipment expenses, are each so much per car mile or per month, it will be found by reference to the manual just what expenses are included in each of these items. It will also be found advisable that in a general way the divisions of expenses in this manual should be made in such a way that the first two general divisions include those expenses which do not add to the value of the property, and the last two general divisions include those expenses that do so add in some degree to the value of the property.

For instance, it adds nothing to the value of the property to pay conductors' and motor men's wages, although it may add to the earnings. It adds nothing to pay clerks' salaries, insurance, or to pay for wrecking or getting derailed cars on the tracks; while it does add to the value of the property more or less to renew the rails and ties, paving, to repair the armatures and steam plant. Or, it would perhaps be better to express it in this way: That the expenses on the two last divisions tend to keep the road in its original state of completeness as when first equipped. In whatever way the expenses are kept, for an intelligent understanding of them, they should be based on a written manual of this nature.

With this as a basis and by following methods similar to those outlined below, a comprehensive and correct statement can be made on a form similar to the form "C" herewith submitted of the expenses of an electrical road, and can be studied by the management with advantage. It will be seen on this form "C" the final result of a month's operation is expressed in four different manners, namely per cent. of expenses to earnings, net earnings, expense per car mile, and expense per passenger. All these have a certain value for comparison. Neither alone tells the whole story.

There has been considerable discussion of late in regard to a standard unit for the comparison of expenses on electric roads. It may be doubtful if such standard unit can be satisfactorily agreed upon or will satisfactorily express the result; but at any rate it must be composed of some function of the results of operation as expressed in this blank.

The next matter is how to arrive at and keep these expenses sufficiently accurate and without too much clerical labor; and this brings us primarily to the Stock or Supply Account. All material while in the stock room and until used evidently bears the same relation to the company as cash in the till or bank, except for availability, and should be so treated. Material should not be charged to the expenses of the road until used, and should be charged when used regardless of the bill for this material being received or paid.

A careful record should be kept of all material received and all material used, on blanks somewhat similar to forms "E" and "D," bound in book form and herewith presented. It is sometimes considered better to have the form "D" on loose sheets instead of bound, and there are variations to be made in the blank to suit individual cases that will be apparent.

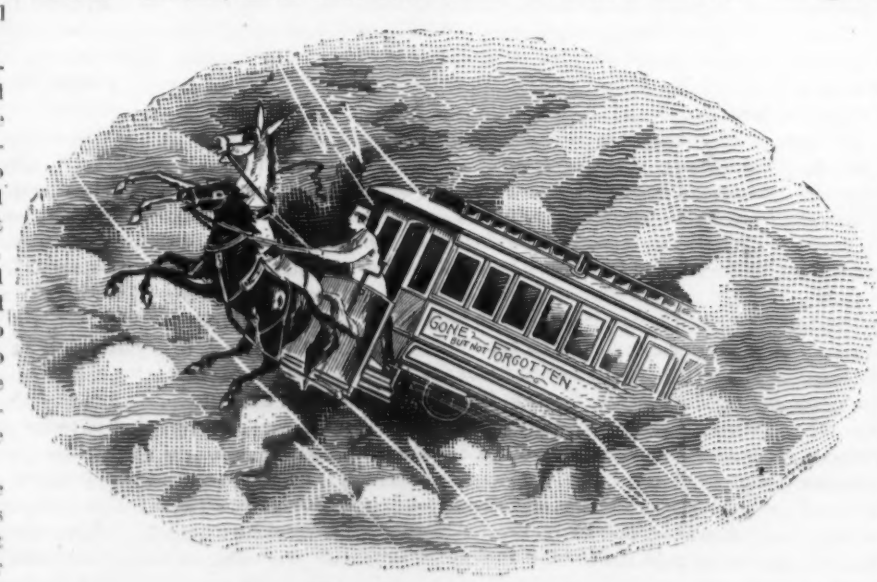
The material received book, or form "E," will be found to pay for itself in checking bills and preventing duplication. The material used is arrived at by charging it out of the stock room on foreman's requisition in small quantities as usual, or obliging a foreman to make a daily or weekly or monthly report of the material he uses on a proper form. A simple form is that of form "F" herewith. One man should receive all the material for the road; he may of course be a storekeeper for this purpose, if the road is sufficiently extensive, or, if not, this duty may be added to the other duties of the clerk.

An invoice book with copies of all bills should be kept, and a monthly summary of both books will be made giving from the invoice book all the charges to stock, and from the material used all the credit to stock and all the charges of material to expense properly classified. If, in addition, a stock ledger is kept, it will be found that all errors and mistakes in foremen's and in clerks' pricing, etc., will correct themselves, and it will be easy at any time to check up the ledger with the material actually on hand in the stock room.

In regard to the labor, there are many forms of time books used; the one here presented as form "P" is convenient, and the foremen soon learn to classify their time with little trouble and few mistakes. On the pay roll should be classified these expenses, and the total of all expenses is easily arrived at.

The mileage sheets, form "A," will be found very complete, and will give a record of the mileage of each car per month. The original records can be taken from the conductors' reports most easily on a blank book and transferred to these reports monthly. The conductors' reports should cover a report of the number of passengers carried on each trip, the number of trips made and the route. There are many excellent forms for these.

To summarize. If the superintendent, as is frequently the case, has an office distinct from the office of the company, he would be required to have the following books: stock ledger, time books, pay rolls, material used and material received books; and copy books as follows will be a convenient arrangement: a letter book, a copy book for pay rolls, a requisition book, unless he buys his own supplies wholly, when this becomes an order book, a daily report of earnings book or deposit book, a motor book for copying reports made on a blank form "S," and a statement and bill copying book for bills made against other parties and the monthly reports to be made will be about as follows: mileage report, material used report, balance stock ledger, receipts report, invoice summary. The daily reports would be of daily earnings, and of the condition of motor cars.



"Struck by Lightning."

No treatment has been attempted of the general books of the company, the income accounts, etc., as these are generally well understood, and the remarks here are only elementary; but I have been led to make them by some examples I have had the misfortune to examine when endeavoring to arrive at the expenses of a road.

Under Mr. Baker's direction a manual for the classification of expenditures was prepared by Mr. H. L. Bettes, and used with very excellent results. This manual will be presented to the public in print at a later day. Although that which has been said above both by Mr. Baker and myself cannot be considered as more than a series of suggestions, this paper has evidently reached the limit of its proper length for presentation before this body.

DISCUSSION OF MR. CROSBY'S REPORT.

At the conclusion of the report Mr. Crosby made the following motion, namely:

That a committee on standardizing of ratings, nomenclature, dimensions and accounts for electric street railways be appointed by the association.

Mr. Macfarren, of Pittsburgh: It is with peculiar pleasure that I rise to indorse this motion. I have long felt the necessity for some uniformity in this respect, and it is time, in my opinion, that the association took such a step, so as to keep in rank with similar societies, which have all adopted methods of this character. I venture to state that no matter of business has ever been taken up by this association, so far as I have been able to familiarize myself with its proceedings, which will be productive of such good results as the matter now before us.

Mr. Crosby's motion was adopted, the committee to consist of seven members, including the president and secretary.

The Committee on Nominations reported in favor of the following officers for the year 1891–2: For president, John G. Holmes, Pittsburgh, Pa.; first vice-president, Thomas H. McLean, New York, N. Y.; second vice-president, James B. Speed, Louisville, Ky.; third vice-president, Albion E. Lang, Toledo, O.; secretary and treasurer, Wm. J. Richardson, Brooklyn, N. Y. Executive Committee: Henry M. Watson, Buffalo, N. Y.; Lewis Perrine, Jr., Trenton, N. J.; W. Worth Bean, St. Joseph, Mich.; Murry A. Vernor, Pittsburgh, Pa.; Thomas C. Pennington, Chicago, Ill. The committee also recommended Cleveland, O., as the place for the next meeting.

These gentlemen were then elected as officers of the association for the ensuing year.

There was a very spirited discussion on the subject of the place of the next meeting, but upon calling the roll it was seen that the vote was largely in favor of Cleveland, where the next meeting will be held. After the usual resolutions of thanks the association adjourned to meet at Cleveland, O., next October.

At the banquet on Thursday night, Congressman Stone, speaking of the substitution of electric for horse power on the Pittsburgh street railways, said: "A Pleasant Valley car can go from the Pittsburgh station to the power house in 19 minutes. It used to take 40. The company used to carry 8,000 people a day. Now it averages 22,000 a day, and gaining. Our officers are God-fearing men, some of them, and they chose electricity as a motive power because it seemed to have the warrant of Scripture—Nahum ii., 4:

"'The chariots shall rage in the streets, they shall jostle, one against another in the broad ways, they shall seem like torches, they shall run like the lightnings.'

"Job xxxviii., 35: 'Canst thou send lightnings that they may go and say unto thee, here we are.'

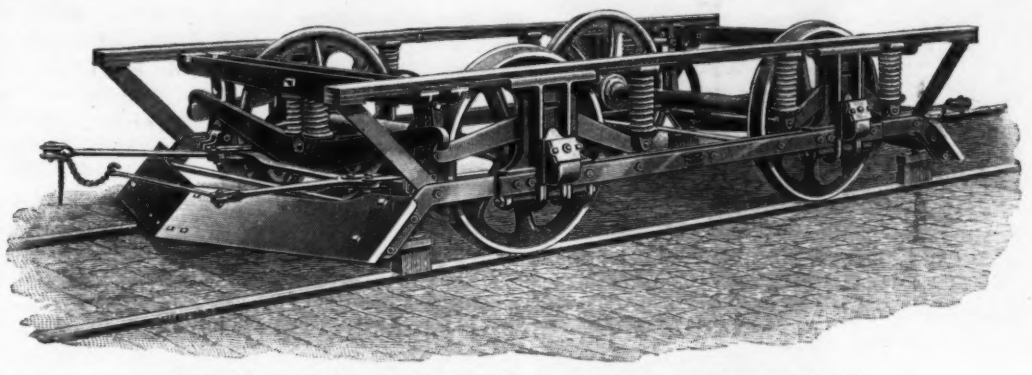
"But the passage in Ezekiel vii., 19, seemed to have the most direct application: 'They shall cast their silver in the streets.'

"The people demanded rapid transit, and they had to furnish it or give way to those who would. They were unable to find anything in Scripture about a cable railway. They doubted whether Job or Nahum or Ezekiel ever saw one, but they believed they must have seen electricity. They hardly knew what system to adopt. They were very much impressed with the storage battery. The Pleasant Valley Company planted the first pole, and were the first to give the people rapid transit. This caused trouble, and the articles published on the deadly overhead wires would now make interesting reading for a lunatic. All prejudices have since been overcome."

Convention Notes.

THE EXHIBITS.

The necessities of street railway traction, since electricity has been used as a motive power, have brought out a vast number of new appliances that are constantly attracting attention and being generally used by leading street railways of the country. Sightseers and delegates to the convention were given an opportunity to see many new and interesting appliances, and to judge of the merits of each in many cases from actual working tests. Chief and most interesting to the majority of the visitors present were the exhibits made by the rival systems of electric traction. Placed on an equal basis, the various representatives of these companies vied with each other in showing up the merits of their systems, and delegates and visitors generally were given an opportunity to judge for themselves in regard to the working of these systems, as all are in use on the various street railway lines in Pittsburgh. The convention city is the home of the great Westinghouse interests, and naturally every effort was put forth by representatives of the company to show up in proper form by practical demonstration the system which is recognized as one of the best in use. The Westinghouse Electric and Manufacturing Company had reception rooms in the Monongahela House, where its representatives cordially welcomed all visitors, and extended a general invitation to all to visit the company's exhibit on the exhibition boat J. M. Gusky, where the double reduction, the single reduction and the gearless motors manufactured by this company were in active operation. One most interesting feature of this exhibit was a single reduction motor running in a tank filled with water, the intent being to show that the Westinghouse company has solved the problem of operating its system under all conditions of weather. Hundreds of visitors also visited the works of the company on Garrison alley. There the company showed in operation a 300-h. p. generator, a double reduction motor, a single reduction motor, a gearless motor—all mounted on trucks and fitted with test brakes—as well as all the other appliances utilized in street railway work. A practical demonstration of the Westinghouse alternating current electric lighting system was another feature of this exhibit.



THREE RIVERS EQUALIZING ELECTRIC MOTOR TRUCK.

The Sheffield Velocipede Car Company, of Three Rivers, Mich., exhibited an equalizing electric motor truck in standard size and also a nickel-plated model of the same, that was remarkable for its superior finish and the perfection of the mechanical details. This model supported a Detroit Electrical Works motor, and is referred to in the account of its exhibit. Mr. E. B. Lindsley, the general manager of the company, was present, and explained that the special features embodied in the truck included the principle of the equalization of strains, so essential in securing the best results in electric propulsion. A cross equalizing bar is placed across one end of the truck, by means of which a three point suspension of the car body is effected, a double spring being placed in front of and a single spring at the side in rear of the front wheels. The value of this feature in securing flexibility, with stability and perfect alignment, will be apparent to any one acquainted with locomotive construction where a similar principle is employed. Springs are also supported on the bar at each end of the rear axle. The construction of the truck throughout is strong, heavy and perfectly adapted for the work for which it is intended. The wheels are of approved pattern and ground to a perfect equality in circumference, after being pressed upon the axle, thus insuring wheels that will run true with the axle. Self-oiling boxes containing a simple device holding a strip of wool felt close to the axle render any extra attention unnecessary oftener than once in two or three months, even when the traffic is heavy. The operating mechanism of the brake is simple and entirely out of the way of the motor, while the shoe brakes are both flange and tread, and when worn can be quickly replaced by simply removing a key. The entire truck may be lifted from either or both axles by simply removing a bolt under the end of the axle. This improved truck is in use on several roads, and it is said is giving entire satisfaction. (See illustration.)

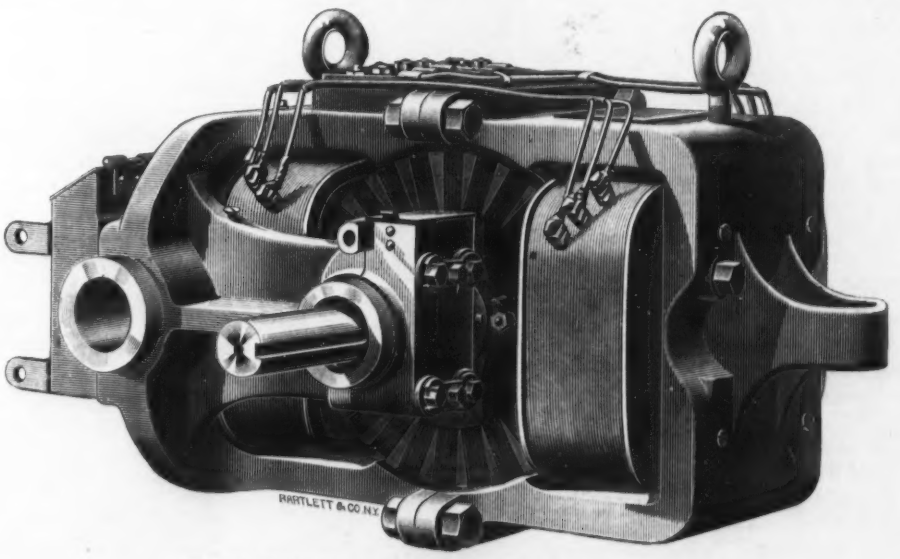
The heating of railway cars by electricity is being received with much enthusiasm, and bids fair to do away with the "deadly car stove." Many admirable systems of electric heating for cars have been invented which are cheap, effective and easily operated. One of the systems which is coming rapidly into notice is that of the Carpenter Electric Heating Manufacturing Company, of St. Paul. The exhibit made by this company occupied a conspicuous place in the hotel and attracted general attention. The company has been manufacturing electric heating apparatus for some time and has recently turned its attention to car heating. A practical display of its heating system was in charge of Mr. C. E. Carpenter, a representative of the company. The heater consists of a thin plate of cast iron two feet long, three inches wide and one-eighth inch in thickness, to one side of which the resistance wires are attached, but insulated therefrom by means of a coating of enamel, such as is used on enameled cooking utensils. This enamel serves also to perfectly prevent consumption by electrolysis and oxidation of the resistance wires, giving the only known electric heating apparatus in which these serious defects are avoided. This plate is secured in a substantial manner to the support of the seat just back of the feet of the passenger, and is surrounded by open grate work which completely protects the clothing but does not obstruct in any degree the free radiation of heat from the plate. The advantages claimed for the Carpenter heater are light weight, simplicity, indestructibility, durability, perfect radiation, easily attached or detached. Many expressions were heard from those who witnessed the practical workings of this heater, most favorable as compared with other systems. The company has already received a large number of orders for placing its system of heating with several representative companies of this country. These heaters are for sale by the Eastern Electrical Supply Company, of Boston.

Apparatus of special interest to railway men was the great exhibit made by the Edison General Electric Company, on the ground floor of the Monongahela House. One of the interesting features of this exhibit was the new type of single reduction gear motor, intended to take the place of the older form put on the market last spring. It resembles its predecessor in general arrangement, but has been subjected to marked improvements at the hands of Mr. H. F. Parshall, who has had the problem in charge the past summer. It is a more powerful and convenient machine in every way and has given satisfaction in actual use. Two sizes are manufactured, the one illustrated being of 20 h. p. The motor exhibited was mounted on a Brill truck. A new controlling table for railway power station was of special interest from its perfect mechanical construction and its electrical details, as in this one piece of apparatus are placed all the indicating and measuring instruments as well as resistance coils for regulating the pressure. By this, work in the power station is greatly simplified. Directly over this table was a large sign of the Edison General Company, which consisted of 600 miniature incandescent lamps. Various other supplies manufactured by the Edison General Electric Company were shown, which were explained to the visitors by the large number of representatives of the company who were present to assist in entertaining. Over the entrance to the exhibit was a monogram of the Edison Company, "E. G. E. Company," in various colored miniature lamps inviting the passer-by to examine apparatus manufactured by one of the leading companies in the United States. This exhibit attracted immense crowds, and was pronounced by all one of the most interesting and representative displays at the convention.

The display made by Alexander, Barney & Chapin, of New York, was one of the most novel of any of the exhibits. It was located in the most prominent place in the hotel, just in front of the ladies' parlor. The firm was represented by Mr. Chas. E. Chapin, vice-president, and Mr. Henry G. Issertel, of the railway department. The exhibit was one of the most neatly arranged and showed off to the best advantage of any made. It consisted of a line of electrical supplies, switches, lamps, lamp sockets and electrical railway specialties and the A. B. C. railway lamp which, possesses an improvement in the form of a carbon support sealed in the tip of the bulb, which prevents the excessive vibration and rupture of the carbon filament. An amusing feature of this exhibit was a set of signal horns which were operated by a dry battery, from which frequent blasts were sent out which immediately had the effect of drawing a crowd. Whenever these signal horns were sounded it was immediately followed by the loud ringing of a bell in the parlors near by, which had the effect of bringing the crowd to the headquarters of the Electric Merchandise Company, of Chicago, whose exhibit consisted of trolley wire insulators, the Chicago clamp, pull-over brackets, England's strain insulators, rawhide pinions, electric headlights, cross-overs and trolleys. The company was represented by W. R. Mason, A. H. England and W. L. Adams. In connection with this exhibit was that of the Burton electric heater for electric railway cars, house and office use. The Electric Merchandise Company is selling agent for this heater.

The Detroit Electrical Works, of Detroit, Mich., had a standard 40-h. p. equipment in operation on the line of the Duquesne Traction Company during the week, that was thoroughly inspected by the street railway officials who attended the meeting. In this new type the details throughout have been redesigned to meet constant service of the hardest character. As is well known, the Detroit system includes but one motor, placed in the centre of the truck and geared to both axles, thus driving the four wheels simultaneously, securing complete traction. All the connections are on top of the motor, and are easily accessible through one trap door. The bushings, commutators and other similar parts are made from their own tempered copper; the insulated gear pinions are of gun metal for the larger cars and of leatheroid for the lighter service, while all nuts are secured by a locking device, the plate of which rests on the countershaft box. The entire equipment is finished in the familiar Pennsylvania red, and the motor developed 47 mechanical horse power under trial. Major C. A. Benton, the general manager of the railway department, established his headquarters early in the week in parlor 54 at the Duquesne House. An elaborate working model of the system was exhibited on the exhibition boat Mayflower, supported by a Three Rivers equalizing motor truck.

A noteworthy exhibit was that of the Thomson-Houston Electric Company. The headquarters of this company at the Monongahela House were presided over by Mr. H. L. Cargill. The exhibit consisted of overhead attachments and various railway supplies. On the boat both single and double reduction motors were shown and a new trolley drop "with gearing." The Thomson-Houston company had a large number of representatives present from Boston, Chicago, Cincinnati, Washington, Atlanta and Syracuse, N. Y., all of whom assisted in entertaining. This company has recently made a new departure by opening up a railway supply department in Boston, which is in charge of Mr. Elmer T. Morris. Hereafter all stock will be shipped from Boston and not carried in Lynn, as heretofore. The company at the present time does not restrict the sale of its overhead line material and supplies to Thomson-Houston roads, but sells to all companies. A large amount of advertising matter was distributed, among which was a new price list, recently issued. The Thomson-Houston exhibit was interesting and one of the largest made, representative in its features, and showing to the best advantage one of the greatest systems in the country, and one in general use, it being stated that 2,870 cars are now operated by the Thomson-Houston system alone, representing 190 companies.

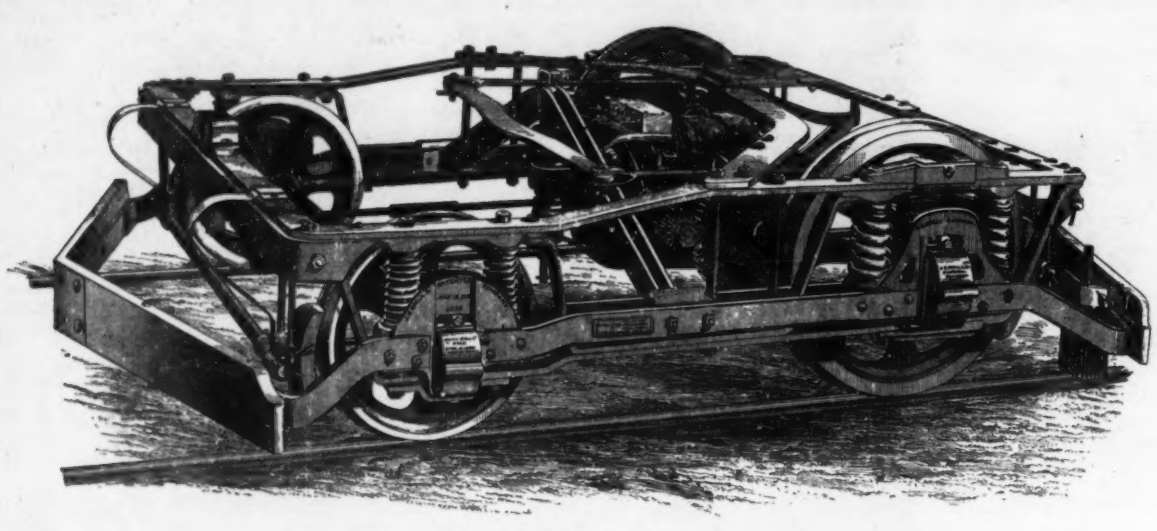


NEW EDISON 20 H. P. RAILWAY MOTOR.

In parlors at the Monongahela House especially fitted up for the purpose the visitor found representatives of the Short Electric Railway Company, of Cleveland. This company is undoubtedly one of the largest and most successful railway manufacturing companies in the country and ranks with the other great systems in the volume of business done. The Short company is the original patentee of the gearless motor as applied to street railway traction. It had a large and prominent exhibit of its motors on the exhibition boat, and cars fitted up with the gearless motor ran hourly from the Monongahela House over the Pitts-

burgh and Birmingham street railway lines, carrying delegates and visitors to the convention, showing a practical demonstration of the working of the Short gearless motor. Whenever requested, representatives of the company willingly put the necessary instruments on the cars to show the power required. Most favorable comments were expressed on every side at the cordial treatment received from the Short Electric Railway representatives, and the company appears to have captured the city, delegates and visitors. The exhibit was in charge of Mr. S. B. Fortenbough and Mr. J. H. Gibson, constructing engineer of the company.

One of the most extensive and attractive displays was that of the Western Electric Company, of Chicago. The exhibit consisted of a line of electric supplies, including line material, hard drawn copper trolley and



NEW BRILL ELECTRIC RAILWAY TRUCK.

weatherproof feeder wires and electric light supplies of all kinds. The Western Electric Company has factories located in New York, Chicago, London, Paris, Berlin and Antwerp, and commercial agencies in Mexico and Melbourne, and is a large manufacturer and dealer in annunciators' bells, pushes, electric gas-lighting apparatus, speaking tube telephone systems, watchmen's electric clocks, automatic mercurial fire alarms, batter and battery supplies, and all kinds of insulated wire, American district apparatus, telegraph instruments, telephone exchange apparatus, testing instruments, line wire and other line material, builders and repairers' tools. Its specialties are hard-drawn copper wire, weatherproof feeder wire, and the Patterson cables for electric light, telegraph and telephone use, for overhead, under ground and under water. This company was represented by Mr. E. W. Bennett and Mr. M. B. Austin, of the Chicago house, and by Mr. S. A. Chase, of New York.

Coincident with the growth in rapid transit is the demand for trucks more perfect mechanically and better adapted to meet the changed conditions that could only be appreciated, studied out and remedied in actual contact with daily work. This the McGuire Manufacturing Company, of Chicago, has endeavored to do and took pride in exhibiting its new form of maximum traction truck, the essential new feature being the combination of an elliptic spring arranged to act as an equalizer. The truck is pivoted to the car body at the centre of the truck, and, besides, has two side bearings and one end bearing. This causes the upper truck frame to always remain parallel with the car body and perfectly distributes the weight on the axles in proportion to the capacity of the springs, which are arranged to support from two-thirds to three-quarters of the weight on the motor axles, leaving but a quarter of the weight on the idle axles. Mr. J. W. Cook was the company's representative.

An exhibit which attracted more than ordinary attention was that of the Eastern Electrical Supply Company., of Boston. The representatives of this company, Mr. Maybin W. Brown, president, and Mr. J. Edward Wallace, are deservedly popular, and are hard workers. Their parlors at the Monongahela House were crowded every day of the convention with interested spectators who were shown the various electric railway specialties handled by this company. The patent Emmett headlight, Winton insulators, Beacon incandescent lamps, extra flexible cable, Cook's portable rail switches, Portland car ventilator, and a complete line of appliances for overhead construction, were shown up to the best of advantage by the genial representatives of the company, which is well known for business integrity and has a wide reputation as one of the leading electrical supply houses of the country.

The general display of street railway supplies was very large, every available foot of space at the Monongahela House and on the boat being occupied by some kind of an invention for street railways. The Electrical Supply Company, of Chicago, whose factories are at Ansonia, Conn. had a most attractive exhibit of street railway specialties, prominent among which were new styles of trolley wire clips and insulators, raw hide pinions, Wood's trolley catch, Wood's duplex fuse box, the C. & D. reed feed oiling journal, Wood's car connector, the Sunbeam railway lamp, the McTighe switch, the Wirt volt and ampère indicator, Wirt dynamo brush, fuse wire, magnet wire, shield brand feeder wire, and special Habirsha feeder wire. The company was represented by Mr. M. M. Wood, electrician, and Mr. William Taylor, assistant manager.

Many interesting and practical styles of car trucks for electric car traction were shown by prominent manufacturers of the country, among which the exhibit of the Peckham Truck and Wheel Company, of Kingston, N. Y., was especially noticable. By the use of this truck the car body is supported on the springs upon the side frames and given additional steadiness by the double plungers bearing in the yokes. To this is added the cushioned wheels, which have been extensively introduced by Mr. Peckham, making a thoroughly flexible truck and one which gives smooth riding of the cars and freedom from sudden jars. The company was represented by Messrs. Edgar Peckham, president; E. C. Stark, secretary and treasurer, and B. A. Hughes, sales agent.

A simple device with which practical demonstrations were made was exhibited by the Johnston Safe Automatic Electric Company, of Richmond, Va. This company manufactures the Johnston electric current disconnector, which is said to render the overhead system perfectly safe, so that there need be no fear of destruction to life or property from falling trolley wires. The exhibit was in charge of Mr. A. L. Johnston and Mr. F. B. Jacobs, the latter secretary and treasurer of the company. The practical tests of this device given for the information of the visitors were very intere-ting and it is looked upon as one of the greatest advances made in electrical engineering.

The J. G. Brill Company, of Philadelphia, Pa., manufacturers of Brill trucks, had an important display, among which was a No. 13 truck manufactured by this company, which presents some of the latest and best ideas as to the proper making of motor trucks. This truck is especially adapted for working over uneven tracks. It is said to be the most popular truck which this company has yet produced, over 250 having been sold, although it has only been on the market for a short time. An illustration of this truck is shown on this page. The representatives of the company were Messrs. J. A. Brill, Edward Cline, J. A. Hanna and Payson K. Andrews.

One of the representative companies at the convention, whose exhibit attracted universal attention, was the New York Car Wheel Works, of Buffalo, whose display was in the main hall at the Monongahela House. The exhibit was made up of the celebrated machined wheels manufactured by this company, which were tastefully arranged amid decorations of ferns and potted plants. The company had its headquarters in parlors of the hotel, and was represented by Mr. Jos. R. Ellicott, of New York, general agent; by Messrs. E. Packer, B. J. G. Haven, Jr., and R. J. Murcer, traveling representatives. An illustration of this exhibit is shown in this issue,

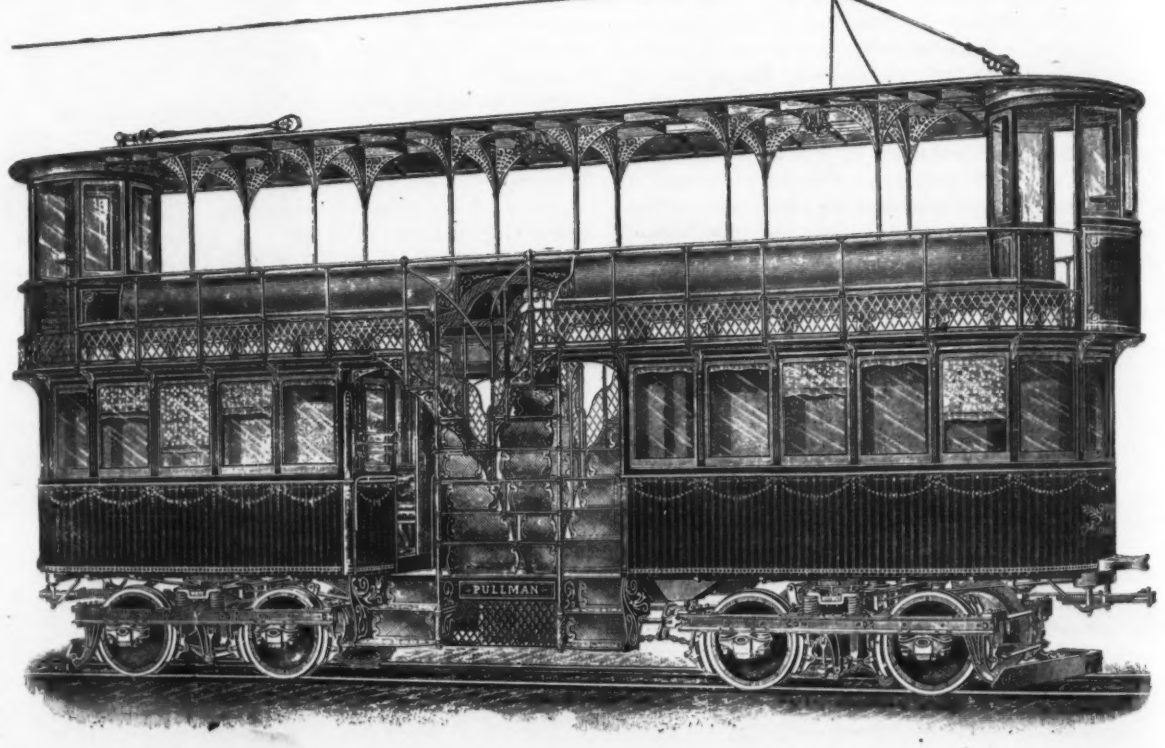
The Baltimore Car Wheel Company, of Baltimore, Md., exhibited a motor truck of a new pattern, which is made to suit a demand for larger wheels, the wheels being 36 inches in diameter. These trucks are designed for strength, lightness, simplicity and accessibility, as well as to provide for light and heavy loads and permit oscillation. The trucks are fitted with dust and oil tight axle boxes, and all parts are interchangeable, and are built for cable or for electric service. The brakes are operated by a powerful crank movement, which is placed between the wheels. The company was represented by Messrs. John S. Pugh and W. S. G. Baker, Jr.

The Revere Rubber Company, of Boston, made a special exhibit of "Flexite" material, a flexible hard rubber tube, also a line of bell insulators made of "Elliott" compound. This company manufactures all the standard insulators for the Thomson-Houston company. In connection with the exhibit was shown a sample of the largest rubber belt ever made, 143 feet long, 72 inches wide and 10 ply thick. A line of mechanical rubber goods completed the exhibit. The company was represented by Mr. C. B. Elliott, manager of the hard rubber department, and Mr. P. B. Chaney, of Boston.

An imposing exhibit was that of the H. M. Loud & Sons Lumber Company, of Oscoda, Mich. The company was represented by Mr. G. H. Keating, of Bay City, Mich. The display consisted of telegraph cross arms, cedar poles, posts and ties. The company makes a specialty of octagonal poles and the display at the convention was made up chiefly of this style. The H. M. Loud Lumber Company has equipped some of the largest and best roads in the country, and deals in a class of goods hat are an absolute necessity in the equipping of a first-class road.

The Calorific Ventilator Heating Company, of Chicago, manufacturers of calorific and standard car heaters, had a large exhibit. By this system the heating is done by circulation instead of radiation, and it can be regulated to maintain any desired temperature, hard coal being used for fuel. In 1889 the company had one heater in use; in 1890, 173, and in 1891, 1,037 of these heaters are in actual service on street railway lines of the country. The exhibit was under the personal supervision of Mr. Garson Myers, president of the company.

The Morton Safety Heater Company, of 45 Broadway New York, exhibited a system of stored heat for street railway purposes, which consisted of an earthen tube inclosed in an iron pipe to which steam is applied, sufficient heat being stored to keep a car comfortable for several hours. This system is looked upon as safe, economical and simple, and is in use upon several important street railway lines in this country. Mr. E. G. Kenly, president and general manager, and Mr. Eugene Carrington, general superintendent, represented the company.



THE PULLMAN CENTRE VESTIBULE CAR.

The display of the R. D. Nuttall Company, of Allegheny, Pa., was very complete, representing the line of specialties manufactured by this well known firm, among them being standard gear wheels, improved rawhide pinions, metal pinions, bearings and brasses, commutators, axles and shafts, trolleys and trolley wheels, in fact a full line of street railway supplies and repair parts for all electric railway systems. The company was represented by Messrs. C. J. Mayer and W. Groetzinger.

The Railway Register Manufacturing Company, of 1,193 Broadway, New York, was represented by Mr. Edward Beadle, general manager of the company. The exhibit

consisted of the alarm registering punches and the latest improved Monitor register which this company is manufacturing extensively, and which have recently been introduced on the cars of the West End Railway Company, of Boston, and the Brooklyn City and Newtown street railway lines of Brooklyn.

Post & Co., of Cincinnati, Ohio, manufacturers of electric and railway supplies, was represented by Mr. Isaac Kinsey, of the company, and Mr. George H. Carey, New York agent. The exhibit was large and attracted general attention. It consisted of a line of street car trimmings and electrical appliances for electric roads, such as switches, bells, headlights, trolley fixtures and other specialties manufactured by the company.

The Equitable Engineering and Construction Company, of Philadelphia, electrical engineers and contractors, had an attractive display of Standard pole ratchets, Standard line insulators, Standard iron bracket and insulator, Standard trolley, centre curve insulators and overhead frogs. W. A. Stadelman, manager and electrical engineer, represented the company, together with Mr. S. A. Hand, vice-president and mechanical engineer.

A combination car which attracted considerable attention was the Schneider combination car, manufactured by the Schneider Combination Car Company, of Chicago. The company was represented by Mr. John G. Schneider, superintendent and vice-president. These cars are so arranged in their construction that summer cars can be made available for winter use, and winter cars easily changed to open cars.

The Wightman Electrical Manufacturing Company, of Scranton, Pa., exhibited two 20-h.p. single reduction motors, having a controlling device doing away with all cables, and a reversible switch. They also exhibited a trolley called the anti-come-off trolley. The company was represented by Mr. Herman Bergholtz, Mr. D. S. Kennedy and by Mr. D. M. Wightman, president and electrician.

A. Whitney & Sons, Car Wheel Works, of Philadelphia, Pa., was represented by Mr. Louis B. Whitney. The ex-

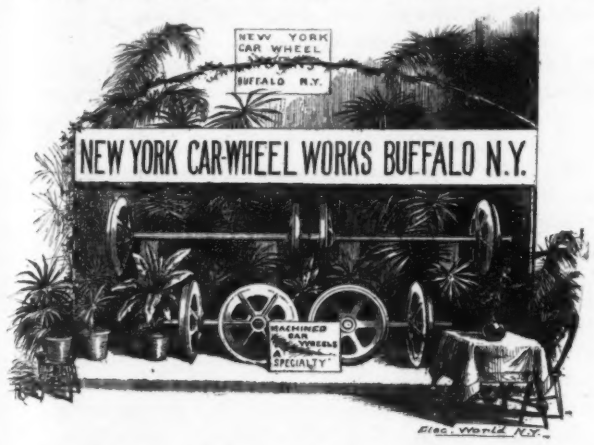


Exhibit of the New York Car Wheel Works.

hibit consisted of a number of electric car wheels taken from a supply which completes a large order for the West End Street Railway Company, of Boston, showing the class of work which this company does. A contracting chill was also shown.

John H. Graham & Co., of New York, had a large exhibit of "new departure car bells." The company was represented by Messrs. C. A. Hoagland and W. A. Graham, who showed up the exhibit in first-class manner. The bells were arranged in a series of tones in such a manner that when struck some very sweet as well as loud tones were produced.

The Jewell Belting Company, of Hartford, Conn., represented by Charles L. Tolles and S. F. Ball, exhibited a fine collection of railway dynamo belts, among which was a 48-inch belt manufactured for the Toledo Electric Railway Co., of Toledo, Ohio. This company is one of the largest manufacturers of belting in the country, and has special facilities for making dynamo belts for light and power plants.

The Solar Carbon and Manufacturing Company, of Pittsburgh, Pa., had an attractive exhibit of carbon motor brushes, self-lubricating brushes and carbon trolley wheels. A large plug was also shown, which measured 6¼ × 48, and is used for melting aluminium. The exhibit was in charge of Mr. F. M. Laughlin and Mr. A. G. Webb, sales agent.

The Forest City Electrical Works, of Geneva, O., was represented by Mr. W. B. Cleveland. The exhibit consisted of Cleveland's section switches, non-flashing, for street use, non-flashing dynamo switches, transfer switches, Cleveland automatic circuit breaker, car lighting switches and fuse switch for feeders, all of which were in operation.

Pierce Brothers & Co., manufacturers and dealers in electric railway supplies, of Leominster, Mass., exhibited automatic switches, single and double pullovers, insulated crossings and line breakers, also movable track drills for making electrical connections. The company was represented by Mr. H. I. Pierce. (See illustration.)

The Lewis & Fowler Co., of 29 Walworth street, Brooklyn, had an exhibit of rails and street railway equipment which this company manufactures. The representatives of the company came to Pittsburgh by special train, attended by a large number of friends and patrons of the company, who were present by special invitation as their guests.

The Rochester Car Wheel Works, of Rochester, N. Y., exhibited a number of street car wheels manufactured from Salisbury iron in Barr contracting chills, with treads ground. The interests of the company were looked after by Mr. F. D. Russell, general agent for New York City; Mr. C. T. Chapin, president, and Mr. C. I. Donahue.

The Hale & Kilburn Manufacturing Company, of Philadelphia, Pa., had an attractive exhibit of car seats, showing specimens in wood strips, rattan, carpeted upholstering and canvas-lined rattan seating. This company also manufactures a patent reversible car seat which is very popular. Mr. E. S. Canman represented the company.

The Engineering Equipment Company, of 143 Liberty street, New York, had an exhibit of Underwood cotton leather belting, electrical railway supplies, Habirshaw wire and cables, patent hard fibre conduits, steel, iron and wire

Exhibit of the Pittsburgh Hollow Ware Company.

poles, and the "Boston" trolley. The representative of the company was Mr. W. F. O. Crane.

The Lieb Machine Works, of New York, exhibited a new trolley bell, clip and trolley, the bearings of the wheel being in the fork instead of in the wheel itself. A line of wooden strain insulators and other street railway supplies and appliances was also shown by Mr. H. H. Harrison, representative of the company.

The Standard Paint Company, of New York, was represented by Frank S. De Ronde. The exhibit consisted of insulating tape, armature varnish, P. & B. insulating compounds, waterproof insulating tapes, paper and waterproof canvas, switchboxes and electrical compounds manufactured by this company.

The Reliance Gauge Company, of Cleveland, O., had a general exhibit of safety devices for the prevention of the burning of steam boilers, many of which are in use by over 150 electric railways in the United States. The company was represented by Messrs. A. J. Wright, president, and George B. Clark.

The Griffin Wheel and Foundry Company, of Chicago, manufacturer of machined wheels for electric motors, was represented by Messrs. A. G. Wellington, secretary, F. L. Whitcomb and W. F. Newberg. The exhibit consisted of a complete line of car wheels adapted to the different sizes of electric motors.

The United States Graphite Company, of Saginaw, Mich., manufacturers of "Graphite" products, was represented by W. H. Wilmot. The exhibit consisted of graphite in its natural state and various other manufactured products of the company, such as graphite lubricant, paints, car grease, etc.

The Universal Electric Railway Construction Company, of Philadelphia, Pa., exhibited an important device, the "Universal" clutch, in two forms. This clutch when used can be applied to any armature, prevents the coils from burning out, and represents economy in the operation of street cars.

A new trolley which attracted considerable attention on account of new features in its construction was the Duncan trolley and wheel, manufactured by the Pittsburgh Trolley Company. The company was represented by Mr. William Duncan, who explained the principal features of his new invention.

The New Process Raw Hide Company, of Syracuse, N.

Exhibit of Pierce Bros. & Co.

Y., manufacturer of raw hide gears, washers, etc., was represented by T. W. Meacham, president, and A. C. Vosburgh, secretary of the company. The exhibit consisted of a general line of goods which the company manufactures.

The Robinson Electric Truck and Supply Company, of Boston, Mass., exhibited a Robinson electric radial car which is especially adapted for sharp curves and is extensively used by the West End Street Railway Company, of Boston. The company was represented by W. A. Robinson.

The lighting of the exhibition barge was done by Ward lamps. These lamps are especially adapted for railway circuits and are manufactured by the Electric Construction and Supply Company, of 18 Cortlandt street, New York, which was represented by Mr. R. B. Corey and Mr. J. C. Knight.

The Pittsburgh Underground Electric Construction Company had a working model of its underground electric conduit system. This company will build three miles of road in Chicago within a few weeks, which will be used for testing the system and for exhibition purposes.

The Gould & Watson Company, of Chicago and Boston, exhibited a line of molded mica insulators for electric railway purposes. The company was represented by Messrs. Edward P. Sharpe and C. Tenant Lee, of Boston, and R. P. Pierpont, the company's agent at Chicago.

The St. Louis Car Company, of St. Louis, manufacturers of horse, cable and electric cars, represented by Mr. P. M. King, exhibited a model of a new centre vestibule car which this company is manufacturing and which is in use on several street railway lines in St. Louis.

The Washburn & Moen Manufacturing Company, of Worcester, Mass., had a very neat exhibit in a handsome case, which was made up of sections of copper cables, railway cables, hoisting cables, suspension bridge cables, trolley wire and guy and rigging ropes.

Barber, Stockwell & Co., of Cambridge, Mass., manufacturers of railway supplies, were represented by Mr. P. A. Dowd, who exhibited a full-sized working model of Dowd's gravity track cleaner, a new cleaner which will shortly be placed upon the market.

The Boston & Maine Gate Company, of Lynn, Mass., exhibited an improved gate adapted to railroad crossings. It consists of an improved gate arm, which can be attached to any railroad gate. The company was represented by Mr. Joseph H. Potts, president.

The Thomson-Houston company had a large electric snow plow on exhibition, and if the amount of dust it raised is to be taken as any criterion of its effectiveness in raising snow blockades, it would seem that it could not fail to do the work required of it.

Henry B. Williams, of Rochester, N. Y., exhibited Williams' radial truck, which does away with friction on short curves, and keeps the driving wheels always parallel with the rails, turning a 24-foot car in a 10½-foot radius. The trucks are reversible.

The Walker Manufacturing Company, of Cleveland, O., manufacturer of improved railway machinery, was represented by Mr. John Walker, president of the company,

Exhibit of the Bodifield Belting Company.

who exhibited a small working model of Walker's patent differential cable drum.

Badger Brothers, of West Quincy, Mass., had an exhibit of Badger's patent self-oiling trolley wheel. This wheel is made of composition metal, makes no noise and does not rattle or slip in operation. The company was represented by Mr. F. L. Badger.

Mr. Joseph Gardam, of William Gardam & Son, New York, experts and manufacturers of mechanical and electrical models exhibited several samples of their work. This firm makes a specialty of assisting inventors in developing their productions.

The India Rubber and Gutta-Percha Insulating Company, 315 Madison avenue, New York, was represented by Mr. C. R. Fields, who exhibited underground feeder wires for street railways, leaded and stranded, manufactured by this company.

The Mitchell-Brant Copper Company, of Erie, Pa., was represented by Mr. A. L. Daniels. This company manufactures commutator segments and copper castings of all kinds and the exhibit was made up of samples of these goods.

The Meaker Manufacturing Company, of Chicago, Ill., was represented by J. W. Meaker, president, and Mr. Norton, secretary of the company. This company manufactures the Meaker combination register for registering car fares.

William B. Rhodes, of Allegheny City, Pa., exhibited a number of silver steel car gongs, which are made of heavy wrought metal, and which have a very fine tone, and are manufactured in all sizes for street railway purposes.

The Pennsylvania Steel Company, of Steelton, Pa., exhibited T-rail sections, girder rails and switches and cast steel switches. The company was represented by Mason D. Pratt and Charles S. Clark, Boston agent.

The P. Wall Manufacturing Supply Company, of Allegheny City, Pa., had a display of steel car gongs, torch lamps, oil cans and other electric railway supplies, in charge of Mr. T. B. Wall, secretary of the company.

The Johnson Company, of Johnstown, Pa., had an exhibit of electrical weldings, street railway crossings, chairs, etc. This company operates a large electrical welding plant, and was represented by W. McLain, secretary.

The National Fare Receiver Company, of Nashville, Tenn., was represented by Mr. J. E. Allison, secretary and gen-

er al manager of the company. The display consisted of a number of improved registers for receiving fares.

The Security Register Company, of Boston, manufacturers of fare registers, exhibited stationary and removable registers which are interchangeable and can be changed from car to car without breaking the fare record.

The Bodifield Belting Company, of Cleveland, Ohio, had an attractive exhibit of high grade leather belting, of which an illustration is given in this issue. The company was represented by Mr. C. J. Sweaton, secretary.

The Robinson Machine Company, of Bellwood, Pa., was represented by Mr. Albert E. Hay, of Philadelphia, and by Mr. J. W. Peugh, secretary and treasurer of the company. The exhibit consisted of electrical car trucks.

The Mansfield Electric City Tramway, 109 Liberty street, New York, was represented by Mr. F. Mansfield, who exhibited a sectional model of the system which represented a casting of one ton in weight.

The Eddy Electric Manufacturing Company, of Windsor Conn., manufacturers of electric motors and power generators, was represented by Mr. F. C. Ross, special agent, who exhibited a 500-volt Eddy motor.

The American Electrical Works, of Providence, R. I., were represented by Mr. P. C. Ackerman, New York agent, who exhibited a full line of samples of electric wires manufactured by this company.

The Standard Underground Cable Company, of Pittsburgh, Pa., represented by Mr. Arthur A. Anderson, exhibited a line of feeder wire for underground and aerial use, also magnet and trolley wire.

Wallace & Sons, of Ansonia, Conn., manufacturers of hard drawn copper wire, displayed several large reels of hard drawn copper trolley wire. Mr. James Goldmark had charge of the exhibit.

The Partridge Carbon Company, of Sandusky, O., showed a large assortment of carbon motor brushes of various sizes and patterns. The company was represented by Mr. James Partridge.

W. H. Weston & Co., of Philadelphia, had an exhibit of Weston quick break switches, a new railroad switch and other appliances, which were shown with good effect by Mr. A. E. Plowman.

The H. A. Williams Manufacturing Company, of Boston, Mass., exhibited Bryant's portable rail saws by means of which a steam or street rail can be cut without removal from the ties.

The Fulton Foundry Company, Cleveland, O., exhibited electric car trucks and steel-tired wheels. Mr. C. J. Langdon and Mr. W. E. Haycox were the company's representatives.

The Brooklyn Railway Supply Company, 123 Chambers street, New York, had a special exhibit of snow-sweeping machinery. Mr. C. B. Allyn represented the company.

The Fitzgerald-Van Dorn Company, of Lincoln, Neb., represented by W. T. Van Dorn, general manager, exhibited an automatic cable and motor coupler for street cars.

The American Tube and Iron Company, of Pittsburgh, exhibited electric railway and trolley poles. The construction of the pole is telescopic, made in three sections.

The Charles Munson Belting Company, of Chicago, had an attractive exhibit of "Eagle" and dynamo belting and was represented by J. H. Shay and N. H. Byam.

The Pittsburgh Steel Hollow Ware Company had an exhibit of steel bells and gongs manufactured of wrought steel by an entirely new process (see illustration).

The Lamokin Car Works, of Chester, Pa., represented by Mr. Henry Cochran, had an attractive exhibit of models of specialties which the company manufactures.

The Interior Conduit and Insulation Company, of New York, exhibited its system of bare conductors for underground conduits, for electric street railways.

Charles A. Schieren & Co., of New York, manufacturers of perforated electric belting, had an exhibit and were represented by Mr. E. P. Atkinson.

The Brownell Car Company, of St. Louis, had on exhibition a new accelerator car, which embodies novel features in street car construction.

Fairbanks, Morse & Co., of Chicago, had a display of Barrett's improved street car and track jacks, for which the company is sole agent.

Bryant & Barbey, of Boston, represented by Mr. F. A. Barbey, had an exhibit of a portable rail saw and the Webster rail joint.

The Price Railway Appliance Company, of Philadelphia, Pa., exhibited a line of street railway structures and metallic cross ties.

A trolley wagon for line work was exhibited by Dwight B. Dean of the Electrical Merchandise Company, of Chicago, Ill.

C. E. Mark, of Cleveland, O., had an exhibit of rail chairs, joint bridges and other street railway equipments.

A new patent model of Daly's adjustable guard and brake for cars was shown by M. Daly, of Allegheny, Pa.

The Bridgeport Brass Company, of Bridgeport, Conn., exhibited several reels of trolley wire.

The Tripp Manufacturing Company, of Boston, Mass., had an exhibit of metallic packing.

John G. White, of Allegheny, Pa., had an extensive exhibit of electric railway insulators.

The Gisholt Machine Company, of Madison, Wis., exhibited renewable rim motor gears.

Pomeroy & Fischer, of New York, had a display of street car varnishes and car colors.

GENERAL NOTES.

The Great Western Electrical Supply Company, South Canal street, Chicago, distributed a large number of its catalogue No. 24, issued by the railway department, including illustrated descriptions of material for car equipment, tools for construction work, line material, station material, etc. A few copies of a new 400-page No. 24 were also distributed, comprising all the goods in its electric lighting department.

The Pullman Palace Car Company, of Pullman, Ill., distributed illustrated, descriptive circulars of a new double deck, centre vestibule street car. A description of it was given in our issue of Oct. 24, and an illustration of the same car appears in this issue. This car has been shipped to Boston, and will be used on the lines of the West End Street Railway.

Wm. Baragwanath & Son, of Chicago, had some handsome wall banners hung up calling attention to the Baragwanath steam jacket feed water boiler and purifier, the Baragwanath live steam feed water superheater and purifier, and the triple acting power boiler feed pump. Descriptive circulars, price lists and catalogues, were also distributed.

Charles S. Besly & Co., of Chicago, Ill., were represented at the convention by Mr. D. G. Kimball. This firm is the sole agent for North America for the Helmet Brand solid oil, which is adapted for use on all kinds of machinery, railroad cars, electric machinery, etc.

J. J. Ryan & Co., of Chicago, distributed a neat circular calling attention to their unequaled facilities for turning out castings in brass, aluminium or aluminium brass, for electrical purposes. This company has the largest jobbing brass foundry in the West.

The Benedict & Burnham Manufacturing Company, of New York, manufacturers of hard drawn copper wire, was represented by Messrs. E. H. Oswald and D. L. Hungerford, who distributed advertising matter and samples of wire.

Dravo & Black, of Philadelphia, Pa., were represented by Mr. F. Dravo. This company contracts to put in complete equipment for power plants, and is agent for the Ball Engine Company, of Erie, Pa.

The United States Mineral Wool Company, of 2 Cortlandt street, New York, distributed samples of copper gaskets and descriptive reading matter describing the uses and merits of mineral wool.

The Huyett & Smith Manufacturing Company, of Detroit, distributed circulars illustrating the hot-blast apparatus in use by the Union Depot Street Railway Company, of St. Louis, Mo.

The Nubian Iron Enamel Company, of Cragin, Ill., called the attention of street railway officials to the value of Nubian enamel in protecting exposed iron work.

The Frost Veneer Company, of New York, was represented by Mr. W. P. Sequine, who distributed samples of veneering bearing the card of the company.

The Acme Safety Emery Wheel Company of Detroit, Mich., distributed circulars descriptive of its safety emery and corundum wheels.

SOUVENIRS.

The large number of souvenirs which were given away by exhibitors and representatives of manufacturing companies at the convention was especially noticeable. Many of them were very elaborate, in great demand and some worthy of special mention. All of the exhibitors distributed and circulated a vast amount of descriptive reading matter.

The Short Electric Railway Company distributed some exceedingly handsome literary and descriptive matter. An elegantly illustrated quarto pamphlet printed on heavy paper and bound with a rough cover, pierced by colored ribbons, was a thoroughly artistic design, descriptive of the apparatus manufactured by this company. A collection of business cards of the representatives of the company, elegantly engraved and held between red leather covers by rings, was another neat and original idea. Accompanying each book was a strip of street car tickets for the free use of visitors riding on cars equipped with the Short gearless motor.

The Edison General Electric Company, besides distributing an immense amount of descriptive reading matter respecting the Edison system, gave out a neat pocket memorandum book and card case containing some very useful data relative to operating extensive electrical roads and the cost of equipment. The initial letter T with which we begin the report of the Convention is from one of the handsome pamphlets distributed by the Edison Company.

The Electrical Supply Company, of Chicago, Ill., distributed a neat button as a souvenir of the convention. Attached to the button was a handsome blue ribbon on which was stamped in gold "Pittsburgh, 1891." It is shown in the accompanying illustration.

A handsome souvenir, and one which was in great demand, was a handsomely bound volume of twenty-five pages containing a number of half-tone pictures illustrating Pittsburgh. This souvenir was presented to the delegates and others with the compliments of the street railway companies of the city, and will be treasured by all who were fortunate in obtaining a copy.

The John Stephenson Company, Limited, of New York, distributed to all the delegates a handsomely bound morocco memorandum book, containing on the inside cover a brief notice of the car-building business of the company. The front cover is lettered in gilt, and on the back cover is stamped in gold a fully equipped electric car.

The Standard Underground Cable Company, of Pittsburgh, Pa., presented all those who participated in the boat ride on the Mayflower, Friday, with elegant boutonnières, which were bound with colored ribbons, on which was inscribed in gold "Compliments S. U. C. Co."

The Gould & Watson Company, of Boston, Mass., presented the visitor with a set of sleeve buttons of molded mica, very neat as well as useful.

The R. D. Nuttall Company, of Allegheny, Pa., presented visitors to their exhibit with samples of rawhide pinions to be used as paper weights.

E. H. Oswald, of the Benedict & Burnham Company, of New York, distributed a neat Russia leather case containing samples of wire.

The Calorific Ventilating Heater Company, of Chicago, Ill., gave as a souvenir a very neat foot rule made of steel.

The Revere Rubber Company, of Boston, gave out handsome glass paper weights which were much admired.

The Griffin Wheel and Foundry Company, of Chicago, Ill., gave out as souvenirs a leather match case.

Post & Co., of Cincinnati, Ohio, gave away as souvenirs letter weights—a turtle cast in bronze.

PERSONAL MENTION.

The following Edison representatives were present in addition to those mentioned elsewhere: Messrs. A. D. Page, of Harrison, N. J.; John I. Beggs and William F. Brewster, of Chicago, Ill.; W. S. Andrews, of Schenectady, N. Y.; John W. Lieb, of Milan, Italy; John Muir, George W. Mosby, James A. Brett, F. Mansfield, Chas. Hewitt, Ed. L. Draffen, J. C. Bennett and F. G. Fuller, of New York; Geo. W. Silsby, of Washington, D. C.; W. G. Bushnell, of New Haven, Conn.; J. W. Schroeder, W. J. MacConnell, C. C. Adams, Frank Gillett, Julius S. Weyl, I. H. Silverman, M. Lamb and Geo. Breed, of Pittsburgh, Pa., and C. C. Pierce, of Boston, Mass.

The Thomson-Houston Electric Company was represented by Capt. Eugene Griffin, vice-president, together with Messrs. O. T. Crosby, W. H. Knight, H. L. Cargill, Geo. W. Mansfield, Theodore Stevens, Harry T. Barr, W. J. Clark, Mr. Blood, Mr. Smith, G. F. Greenwood, Elmer P. Morris, and Theodore Stebbins, of Boston. From Chicago were Theo. P. Bailey, Geo. Wheeler and Charles Rusling. There were also Messrs. Alex. Lewis, of Cincinnati; Frank H. Clark, of Washington, D. C.; Harry Crowley of Atlanta, Ga.; Prof. Freary, of Syracuse, N. Y., and Howard Wheeler and E. G. Waters, of the Pittsburgh office.

Mr. H. L. Childs, of H. L. Childs & Co., Pittsburgh, large supply dealers and representatives in that territory of Chas. A. Schieren & Co., was a welcome visitor to the convention and has our thanks for courtesies extended during the trip up the river and while visiting the many large factories along the route.

Messrs. Chas. L. Pullman and A. B. Pullman, of the Pullman Palace Car Company, came to the convention by special car, bringing with them a party of friends, and were energetic in presenting to the street railway men the features of the new double-deck centre vestibule street car referred to elsewhere.

The Lewis & Fowler Company, of Brooklyn, was represented by Geo. W. Myers, Wm. C. Wood, Louis E. Robert, Frank A. Morrell, Geo. S. Whipp, W. H. Delany, Chas. S. Mead, John Hutton, Jas. Grady, Wm. Cloonan, and John England, all of Brooklyn.

Mr. F. E. Degenhardt, manager of the western sales department of the Standard Underground Cable Company, was on hand and exerted himself to see that the interests of his company were well looked after.

Chief Engineer Rice, of the Boston Rapid Transit Commission, attended the convention, to pick up information likely to be of advantage in connection with the question of rapid transit in the city of culture.

Mr. T. McCoubrey represented the interests of the Okonite company. Okonite smiles illumined his countenance Okonite scarf pins he gave to his friends and an Okonite grip in parting.

Mr. J. W. Marsh, vice-president of the Standard Underground Cable Company, of Pittsburgh, was at the convention and on the excursion on the Mayflower talking up Standard cables.

Mr. George Standart, secretary and treasurer of the Exhaust Steam Purifying Company, of Chicago and New York, explained the merits of the system which his company controls.

Mr. Frank B. Rae electrical engineer of the Detroit Electrical Works, was present to assist in showing up the merits of his system by a practical test, which is referred to elsewhere.

Mr. M. J. Sullivan, of the Edison General Electric Company, was everywhere present, and in his usual agreeable manner directed his efforts to furthering the Edison interests.

Mr. W. R. Mason, Dr. Leigh Burton and Dr. John Mahoney effectually represented the Burton Electric Company, manufacturers of the Burton heater, Richmond, Va.

Mr. S. Dana Greene, of New York, manager of the sales

department of the Edison General Electric Company, was a familiar figure seen at the Edison headquarters.

Messrs. F. H. Reed and Geo. N. McKibbin, of Reed & McKibbin, consulting electrical engineers and contractors, of New York, spent three days at the convention.

Mr. G. H. Fisher, manager of the Philadelphia branch of Chas. A. Schieren & Co., was one of the representatives of that company looking after its interests.

Mr. W. S. Turner, of the Woodbridge & Turner Engineering Company, New York, took in the convention and looked after the interests of the company.

Mr. H. Ward Leonard, of H. Ward Leonard & Co., New York, dropped in upon the convention Thursday and Friday, and greeted his many friends.

Mr. F. D. Lawrence, representing the Standard Electrical Works, of Cincinnati, O., was present, and put in a good word for Okonite to everybody.

Mr. F. H. Haynard, formerly connected with the Straight Line Engine Company, of Syracuse, N. Y., represented the Ball & Wood Company.

Mr. Frank R. Chinnock, New York State agent of the Edison General Electric Company, kept the crowd moving around the Edison headquarters.

The Wales Manufacturing Company, of Syracuse, N. Y., manufacturers' agent for street railway supplies, was represented by Mr. Geo. S. Wales.

Mr. John D. Elwell, general manager of the Duplex Street Railway Track Company, 52 Wall street, New York represented the company.

Mr. W. G. Whitmore, of the Engineering Department of the Edison General Electric Company, with a large corps of assistants, was present.

Mr. Joel H. Woodman, of Hoboken, N. J., manufacturer of plain and perforated veneer seatings, personally represented his interests.

Mr. George L. Wiley, eastern manager of the Standard Underground Cable Company, was one of the "four hundred" present.

Mr. J. H. Pennington, general manager of the U. S. Railway Supply Company, of Pittsburgh, Pa., represented his company.

Mr. J. P. McQuaid, of New York, treasurer of the National Conduit Manufacturing Company, represented that company.

Mr. Charles D. Shain, district manager of the Edison General Electric Company, added weight to the Edison interests.

Mr. Sidney H. Short, president of the Short Electric Railway Company, of Cleveland, was on hand early in the week.

Mr. W. J. Hammer, electrical engineer, of New York, stopped off on his way from Chicago to greet his friends.

Mr. C. S Van Nuis, of 136 Liberty street, New York, manufacturer of the "Ajax" switch, was ubiquitous.

The Genett Air Brake Company, of Chicago, was represented by Mr. David Reid and Mr. M. L. Rothchild.

Mr. J. C. Bennett, of New York, was one of the representatives of the Edison General Electric Company.

Mr. W. L. Candee, of the Okonite Company, New York, was one of the representatives of that company.

Mr. W. H. Hays, president of the Eureka Nut Lock Company, of Pittsburgh, Pa., was present daily.

Mr. F. A. M. Burrell, of Chas. A. Schieren & Co., New York, was a familiar figure at the convention.

Mr. Charles G. Stearns, of New York, represented the Bemis Car Box Company, of Springfield, Mass.

Mr. James F. Kelly, of the Edison General Electric Company, was on hand Thursday greeting friends.

Mr. R. H. Smith, of the Belt Electric Line Company, of Lexington, Ky., and Mrs. Smith were present.

J. H. Bunnell & Co., of New York, were represented by Mr. Chas. McLaughlin and John J. Ghegan.

The Fort Wayne Electric Company, of Fort Wayne, Ind., was represented by Mr. W. R. Kimball

Mr. J. G. White, of J. G. White & Co., New York spent the entire week in Pittsburgh.

Mr. W. M. Dubois, of Elmira, N. Y., represented the Elmira Steam Generating Company.

Mr. W. H. Gordon, of W. H. Gordon & Co., New York, was a visitor at the convention.

Mr. D. W. Pugh, of the John Stephenson Company, New York, was in attendance.

The New York Insulated Wire Company was represented by Mr. James B. Olson.

Mr. C. S. Rea, of Pittsburgh, represented the Heine Safety Boiler Company.

Mr. A. J. Corriveau, of Montreal, spent Friday in Pittsburgh.

Among others present as representatives of companies or otherwise were the following:

Mr. Willard A. Smith, of Chicago, Chief of Department of Transportation Exhibits, Railways, etc., World's Columbian Exposition.

Prof. W. A. Anthony, consulting electrician of the Mather Electric Company, of Manchester, Conn.

Mr. Edward E. Higgins, of Cleveland, general manager of the Short Electric Railway Company.

Mr. E. L. Babcock, president of the Falls Rivet and Machine Company, Cuyahoga Falls, O.

Mr. W. H. Patton, Superintendent of the Patton Motor Manufacturing Company, of Chicago.

Mr. Edward I. Robinson, general manager of the Laclede Car Company, of St. Louis, Mo.

Mr. M. K. Bowen, of New York, special agent of the Short Electric Railway Company.

Mr. Geo. A. Carey, president of the Bowers Manufacturing Company, Newark, N. J.

Mr. J. M. Orford, of the Union Electric Manufacturing Company, Bridgeport, Conn.

Mr. J. H. Conkling, of the Aluminium Brass and Bronze Company, Bridgeport, Conn.

Mr. J. Potter, of Cleveland, vice-president of the Short Electric Railway Company.

Mr. H. Wray Weller, of New York, of the Edison General Electric Company.

Mr. W. A. Sheldon, of the Schuyler Electric Company, Middletown, Conn.

Mr. W. S. Elliott, of Chicago, of the Edison General Electric Company.

Mr. Walter C. Kerr, Westinghouse, Church, Kerr & Co., of New York.

Mr. Lafayette Cole, representing Holmes, Booth & Haydens, New York.

Mr. J. E. Lockwood, of the Detroit Electrical Works, Detroit, Mich.

Mr. H. W. Smith, of the Smith Conduit Company, Newark, N. J.

Mr. C. A. Gates, of the Russell Engineering Company, Massillon, O.

Mr. Frank J. Sprague, of New York, pioneer in electric railroading.

Mr. D. T. Everett, of the Simplex Electrical Company, New York.

Mr. N. Pfatischer of the Accumulator Company, Philadelphia.

Mr. C. J. Field, Field Engineering Company, New York.

Mr. Allen R. Foote, U. S. Census Bureau, Washington.

Mr. T. J. McTighe, of Barry & McTighe, New York.

Mr. S. S. Leonard, Hill Clutch Works, Cleveland, O.

The Union Electric Company's Double Pole Switch.

The illustrations on this page show the latest and best design of a "pull and push" switch made by the Union Electric Manufacturing Company, of Bridgeport, Conn. Three years ago this company introduced two new switches among the electric light installations in New England which were admirably suited for the work which they were intended to do and which gave excellent satisfaction wherever they were employed. The company claims, however, that the double pole switch it is now introducing is even better than the one formerly put in use. It is also claimed that the mechanical movement of this switch is as perfect as anything that has been used in any switch of this kind. The details have been worked out very carefully and the construction of the switch has been carefully attended to. The interior arrangement of the switch will be easily understood from the illustrations, so that no detailed description of it need be given.

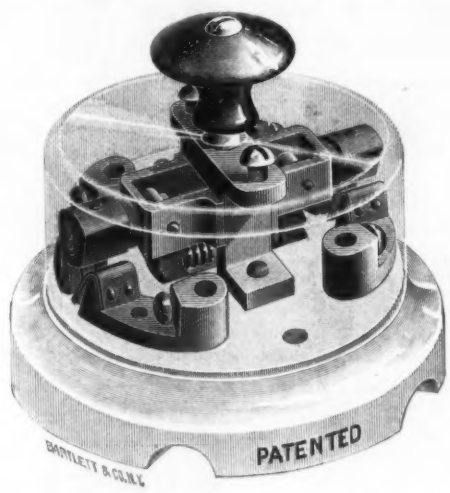


Fig. 1.—Double Pole Snap Switch of the Union Electric Manufacturing Company.

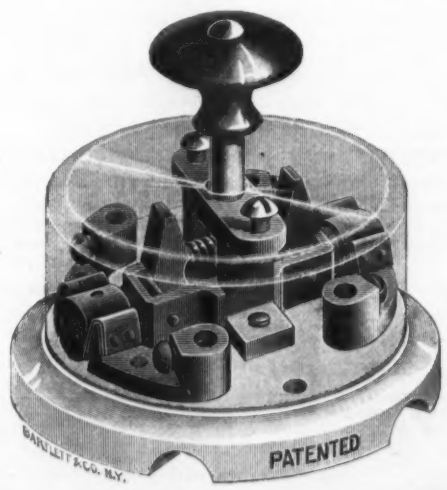


Fig. 2.—Double Pole Snap Switch of the Union Electric Manufacturing Company.

Electricity the Most Economical Power for Street Railways.*

BY J. S. BADGER.

Although the electric street railway has a well recognized commercial existence of some four years, so far little has been known of its actual expense of operation, or its relative economy compared with other modes of street travel. While the need of definite and exact information has been realized, it has been exceedingly difficult to secure sufficient data to be of value for purposes of comparison, or as a means of reaching any definite conclusion.

The data herewith presented concerning electric roads have been very carefully collected, and will enable accurate conclusions to be drawn respecting the relative merits of horses, cable and electricity as a motive power for street cars. The electric roads, which really control the results, have been in operation since the earlier days of the electric railway, and, having passed the experimental stage, their operations are well settled and uniform. In several cases very considerable changes are in progress, but they are such as will conduce to still greater economy of operation.

The elements which enter into a consideration of the questions at issue are:

First cost of road and equipment.
Operating expenses per passenger carried.
Ratio of operating expenses to receipts.
Operating expenses per car mile.

Upon the first and last must rest the decision as to what is the most economical power for street railways.

The element of first cost may or may not decide the question at once. If the capital available is limited to the amount necessary for the least expensive construction and equipment this settles the question of choice of motive power. If the capital is limited only by the ability of the road to pay a reasonable return upon the investment, the question becomes more complex; and whether a cheap or expensive construction shall be adopted depends upon whether the interest charge added to cost of operation will be large or small when divided by the total number of units of comparison.

"Passengers carried per mile of route" or "per mile run" relates chiefly to density of traffic and consequent value of the franchise, and has only a distant bearing upon the question of operating expenses.

Cost per passenger carried, and ratio of operating expenses to receipts, considered in connection with fixed charges, relate to the dividend paying ability of the road, or the value of its securities as an investment, bearing in mind the fact that two roads may show the same ratio of operating expenses to receipts, and one be able to pay twice as much as the other in dividends. Therefore these elements do not necessarily have any bearing upon the actual economy of operation, or give any indication as to which of any two or more systems is the most economical.

Cost per car mile, for cars of about equal carrying capacity, seems to be at present the only basis of comparison. This expense, within the limits of traffic for which the power plant and equipment are adapted, remains pretty constant regardless of variations in amount of traffic, but this is directly affected by change in value in any item of operating expense just to the extent that such variation is part of the whole expense.

Whether a road shall show a high or low cost per car mile depends upon its physical characteristics, the motive power employed, to a certain extent upon whether cars are run singly or in trains, and upon the ability of the man responsible for its mechanical operations.

Whether it shall show a high or a low cost per passenger carried depends to a certain extent upon the foregoing, but principally upon whether few or many can be induced to ride upon it, and therefore upon good management.

A careful examination of the roads in question shows the incorrectness of the statement that those "which have the least expense per car mile have the greatest expense per passenger carried." There is no uniformity in this respect one way or the other, as between different roads. Theoretically, the expense per car mile would slightly increase with an increase in traffic. In a general way, and without attempting to produce any proof in support of this opinion, it may be said that, other conditions remaining the same, the expense per car mile would increase about as the cube root of the number of passengers carried. In this way, and under conditions seldom realized in practice, the foregoing statement might be true.

Expense per car mile, for an electric road, depends chiefly upon cost of fuel, efficiency of steam and electric plant, wages, character of road as relates to grades and curves, and last, but by no means least, intelligent care of machinery, etc. Without a knowledge upon these points a simple statement of expense per car mile conveys little definite information. With coal varying from $1 to $3.80 per ton, its consumption from 4.3 pounds to 12.2 pounds per car mile, a station output from 3.7 to 8.4, and even 10.7 e. h. p. per car in operation, and wages of conductors and motor men from 10 to 20 cents per hour, the importance of these data is at once evident.

Regarding care of machinery, a comparison may not be amiss. In the case of one road, an average of one-sixth of the armatures in use go into the repair shop every month, generally because burned out. Another road using the same system, operating more cars upon heavier grades, has not had an armature burned out in nearly a year. As both do their own repairing, the manufacturing company is relieved of responsibility for this difference. Many similar examples could be given.

In another instance, upon a road of less than 10 miles, there was for months a constant leakage of 20 to 30 ampères on the line.

While, therefore, the manufacturing companies may have been guilty of sins of omission, the operating companies have been guilty of sins of omission and commission. Experience has been costly for both. Electrical apparatus must have intelligent care, or the repair bills soon assume large proportions, and this frequently causes railway companies, who do not understand the true cause of the trouble, to condemn electricity as an expensive motive power. What can be and is actually accomplished in practice is shown elsewhere in this paper; and it is not too much to say that there are few roads, operating under the Edison system, that cannot, at least, closely approach the average of the "Seven Representative Roads" referred to in the tables which are given herewith.

In isolated cases circumstances may strongly favor some one of the three systems under consideration to the exclusion of the others. This must be determined by expert examination; but whichever shows the best results out of

* Paper distributed at the Street Railway Convention, Pittsburgh.

a large number of cases must stand at the head, as the most desirable and economical motive power for street railways.

The item of first cost is the subject of considerable discussion. Direct information concerning cable roads has not been obtainable; but as the figures we cite are those given by the Census Department, and do not seem to have been questioned by any authority upon the subject, they may be accepted as substantially correct. Our data concerning horse roads, being taken from sworn reports to the Massachusetts Board of Railroad Commissioners, can also be relied upon. The figures given concerning investment in electric roads have come from official sources, and are confirmed by private information. These are, however, excessive. Most of the roads mentioned were formerly horse roads, and to the original investment has been added the cost of change of motive power; and in almost every case, the amount now charged to permanent investment is far in excess of what it would cost to renew the entire power plant, track and equipment.

Estimates upon track construction differ greatly, but the limit of profitable investment is not likely to exceed $10,000 per mile; while as fine and substantial a roadbed as electric car ever ran over was built at a cost, exclusive of paving, of about $5,000 per mile.

The overhead structure need not cost to exceed $2,500 to $3,000 per mile of single track for best wood poles, or $3,500 to $5,000 for iron poles. For double track, iron poles, it would vary from $4,500 to $6,500 per mile, centre pole construction being the cheaper, and in many other respects preferable where it can be adopted.

Three thousand dollars to $3,500 per car is a liberal estimate for 16-feet to 20-feet cars, fully equipped, and the average is about two cars per mile of road.

An allowance of 15 to 20 h. p. per car, at $80 to $100 per horse power for station equipment, including steam plant, but not real estate or buildings, is very liberal.

Thus we have, as an extremely liberal estimate, $26,000 per mile, exclusive of real estate, buildings and paving, for a road suitable for the heaviest metropolitan traffic. And it is a fact that a good and satisfactory road can be built and equipped for $20,000 per mile.

As records of actual experience a careful examination of the statistics presented is invited, and especially of those relating to electric railways. The greater part of these has been obtained by personal visits to the roads reported.

COMPARISON OF INVESTMENT AND OPERATING EXPENSES.

TABLE I.

	Total investment real estate, road and equipment.		Car miles run per annum per mile of street length.	Passengers carried annually per mile of street length.	Passengers carried per car mile run.
	Per mile of street length.	Per mile of track length.			
*22 Electric roads	38,500	27,780	76,158	237,038	3.10
†45 Horse roads	33,406	31,093	43,345	251,816	5.81
‡10 Cable roads	350,325	184,275	309,395	1,355,965	4.38

* Car miles run per annum, 14,013,187; passengers carried per annum, 43,614,972; street length, 184 miles; track length, 255 miles.
† All the roads in Massachusetts operated exclusively by horses for 1885-90. Average for six years.
‡ From Census Bulletin No. 55.

TABLE II.

	Operating expenses per car mile run.	Interest charge per car mile at six per cent. on total investments.	Total of operating expenses and interest per car mile.	Cost per passenger carried, interest excluded.	Cost per passenger carried, interest included.
	(Cents.)	(Cents.)	(Cents.)	(Cents.)	(Cents.)
Electric roads	11.02	3.03	14.05	3.55	4.53
Horse roads	24.32	4.62	28.94	4.18	4.98
Cable roads	14.12	6.97	20.91	3.22	4.77

TABLE III.

	Ratio of investment, per mile of street length.	Ratio of car miles run annually per mile of street length.	Ratio of cost of operation per car mile, interest included.	Proportional traffic that must be done, per mile of street occupied, to pay operating expenses and 6 per cent. on the investment.
Electric roads	1.152	1.757	.485	.852
Horse roads	1.000	1.000	1.000	1 000
Cable roads	10.486	7.138	.722	5.154

SEVEN REPRESENTATIVE ROADS, OPERATED ENTIRELY BY ELECTRICITY.

Road.	Length. Of all tracks.	Length. Of road.	Passengers carried annually per mile of road.	Number of cars in daily operation.	Average daily mileage per car.	Average number of passengers daily per car.	Passengers carried per car mile.	Operating expenses per car mile.	Operating expenses per car per day.	Cost per passenger carried.
1	51.0	35.0	*162,857	50	100	313	3.13	12.29	12.29	3.93
2	40.0	19 5	487,582	140	91	188	2.06	7.80	7.10	3.79
3	16.0	10.0	199,000	16	125	343	2.75	8.43	10 54	3.07
4	8.5	5.0	*460,000	20	83	318	3.82	11.82	9.80	3.09
5	15 5	14 0	167,511	18	106	357	3.35	11.00	11.70	3.28
6	28.0	23 5	286,852	31	108	397	5.51	12.74	13.76	2.31
7	3.8	2.8	200,000	5	92	307	3.33	8.49	7.81	2.55
	162.8	109.8	.....	280	.....	.....	.....	9.83	.....	3.28

* Estimated.
Total annual car mileage, 9,862,000. Total number of passengers carried annually, 29,144,000.

Table I. shows that, taking street length as the unit of comparison, in the cases of the roads under consideration, the total permanent investment of the electric roads is only 15 per cent. more than that of the horse roads, while the cable roads cost more than nine times as much as the electric roads. The average speed of cable and of electric cars is about the same, consequently the cable roads ran about four times as many cars per mile of street length as the electric. This would be expected, as the cable roads generally occupy the routes of heaviest travel. The horse roads ran more cars than the electric, for an equal length of road, but the latter, having an advantage in higher speed, greatly exceed in car miles run. The electric roads carried fewest passengers per car mile, but carried nearly as many per mile of street occupied as the horse roads. On account of their more favorable location, the cable roads exceed both the others in passengers per mile of route. The column showing passengers carried per mile run gives a general idea of the relative number of passengers on a car at any one time.

Table II. shows operating expenses per car mile, all taxes and fixed charges excluded, for each of the three systems; interest charge per mile at six per cent. upon the total permanent investment; total of operating expenses and interest per car mile; cost per passenger carried, interest charge excluded, and the same with interest charge included. Upon every point, save the one unimportant one of cost per passenger carried (interest excluded), the superiority of the electric road is plainly evident.

Table III., for greater convenience in comparison, shows the ratios of the three most important items, and the proportional traffic that must be done, per mile of street occupied, for each system, to pay operating expenses and six per cent. on the investment. Here, more than anywhere else, the superiority of the electric road is plainly evident, the last column showing that in but few cases can there be even a question as to which system offers the greatest inducement to the investor.

If the electric roads carried as many passengers per car mile run as the horse or cable roads, which they could easily do, and allowing for the increase in operating expenses due to increased traffic, the cost per passenger carried would be as follows:

	Per passenger. Cents.
At 5.81 passengers per car mile (number carried by horse roads) the cost would be, interest charge excluded	2.38
At 5.81 passengers (as above) cost would be, interest charge included	2.82
At 4.38 passengers per car mile (number carried by cable roads) the cost would be, interest charge excluded	2.82
At 4.38 passengers (as above) cost would be, interest charge included	3.51

This is not in any way an attempt to decry the cable system, as it is undeniable that it has a place of its own, where it is satisfactory to the public and profitable to the investors; but the claim is that, under all usual circumstances, the electric road can handle just as heavy traffic, as readily and satisfactorily to the public, with much greater economy in operation and much less investment of capital.

OPERATING EXPENSES OF ELECTRIC ROADS.

Average of 22 trolley roads. Length varying from 3 to 51 miles; cars in daily operation, 3 to 140; daily mileage per car, 80 to 150; average daily mileage per car, 110.

	Expenses per car mile. (Cents). Highest.	Lowest.	Av'r.
Maintenance of roadbed and track	1.86	.10	.54
Maintenance of line	.95	.01	.12
Maintenance of power plant, including repairs on engines, dynamos, buildings, etc.	.86	.05	.36
Cost of power, including fuel, wages of engineers, firemen, dynamo tenders, oil, waste, water and other supplies	4.95	.48	1.96
Repairs on cars and motors	5.24	.59	1.80
Transportation expenses, including wages of conductors, motor men, starters and switchmen, removal of snow and ice, accidents to persons and property, etc	9.47	2.74	4.98
General expenses, including salaries of officers and clerks, office expenses, advertising, printing, legal expenses, insurance, etc	2.95	.79	1.26
Total	*22.99	*7.80	11.02

Cost of coal varies from $1.00 per ton for slack, to $3.00 for r. o. m. (run of mine), and $3.80 for lump.

Wages of conductors and motor men vary from 10 cents to 20 cents per hour.

Consumption of coal varies from 4.3 pounds of slack per car mile to 12.2 pounds r. o. m. per car mile.

The station output varies from 3.7 e. h. p. (electrical horse power) to 8.4 e. h. p. per car in operation, for roads equipped with 16 feet cars and Edison motors. In the latter case the road had many heavy grades and sharp curves. One road, equipped with 30-foot double truck cars (weight complete about 10 tons), six Edison and 14 Short double 15 h. p. equipments, traffic medium and grades moderate, required an average of 10.7 e. h. p. per car in operation.

The best station performance is one e. h. p. for every five pounds of slack or four pounds of nut consumed; and evaporation of 7½ pounds of water for every pound of slack consumed. Return tubular boilers, Murphy furnaces, Armington & Sims high-speed, single cylinder, non-condensing engines, and Edison generators are in use.

DETAILED DISTRIBUTION OF OPERATING EXPENSES.

For roads of 10 or 15 miles and upward operating 20 or more cars per day, averaging 105 to 110 miles each, grades moderate, a careful distribution of expenses, based upon the experience of the best roads, will *average* about as follows:

	Expenses per car mile. (Cents.)
Maintenance of roadbed and track	.54
Maintenance of line	.12
Maintenance of power plant:	
Repairs on engines and boilers	.180
Repairs on dynamos	.101
Miscellaneous repairs	.078— .36
Cost of power:	
Fuel	.868
Wages of engineers and firemen	.653
Wages of dynamo tenders, etc	.232
Oil, waste, water and other supplies	.218—1 96
Maintenance of rolling stock:	
Repairs on motors (extra gearing)	.695
Repairs on gearing and trolleys	.594
Repairs on car bodies and trucks	.512—1.80
Transportation expenses:	
Wages of conductors and motor men	4.262
Wages of starters, switchmen, track sweepers, etc	.268
Cleaning and inspecting cars	.238
Oil, waste and other supplies	.083
Accidents to persons and property	.061
Miscellaneous	.068—4.98

* Respectively the highest and lowest total for any one road.

General expenses:	
Salaries of officers and clerks	.743
Office expenses	.138
Advertising and printing	.061
Legal expenses	068
Insurance	.161
Miscellaneous	.091—1.26
Total	11.02

SOME REPRESENTATIVE ROADS.

ROAD NUMBER ONE.

Boilers.—Four H. T.; 16x66, with 54 4-in. tubes.

Fuel.—Nut and slack, at $2 per ton. Consumption, 5-7 pounds per car mile.

Engines.—One 250-h. p. Corliss, one 150-h. p. Ball, one 150-h. p. Brown. Generators driven from countershaft, except from Ball engine.

Generators.—Two No. 32, four No. 20. Edison.

Roadbed.—Tram and centre-bearing and side-bearing girder rail. Weight, 45, 52, and 56½ pounds. Four miles paved. Railway company do not pave or do repairing. Length of all tracks, 8.5 miles: street length, 5 miles. Generally good condition.

Grades.—Steepest, 13.2 per cent.; length, 100 feet. General character of road moderately heavy.

Cars.—Total number in equipment, 36 motor; length 14 and 16 feet. Average number in daily use, 20. No trail cars used.

Car Mileage for one year, 601,966; daily average, 1,663; daily average per car, 83.15.

Wages.—Conductors and motor men, 15 cents per hour; engineers, $100 and $90 per month.

DETAILS OF OPERATING EXPENSES.

	Expenses per car mile. (Cents.)
Maintenance of roadbed and track*	1.05
Maintenance of line	.07
Maintenance of power plant:	
Repairs on engines	.035
Miscellaneous repairs	.016— .05
Cost of power:	
Fuel (nut and slack, at $2.00 per ton)	.671
Wages of engineers and firemen	.591
Oil and waste	.063
Water (at 7 cents per 1,000 gallons)	.092
Other supplies	.010—1.43
Maintenance of rolling stock:	
Repairs on motors (ex. gearing)	.917
Repairs on gears and trolleys	.224
Repairs on car bodies and trucks	.501
New attachments	.204—1.85
Transportation expenses:	
Wages of conductors and motor men	4.635
Wages of starters, switchmen and track sweepers	.318
Removal of snow and ice	.137
Accidents to persons and property	.026
Cleaning and inspecting cars	.298
Oil, waste and other supplies	.032
Animals, registers and sundries	.268—5.72
General expenses:	
Salaries, insurance, etc	1.532
Office expenses	.041
Advertising and printing	.051
Legal expenses	.004
Miscellaneous	.018—1.65
Total	11.62

ROAD NUMBER TWO.

Boilers.—Four H. T., 14 x 78.

Fuel.—Nut and slack, at $1.75 per ton. Consumption, 11 pounds per car mile.

Engines.—Two 125-horse-power Taylor-Beck; one 175-horse-power Taylor-Beck; and (put in July, 1891,) one 250-horse-power Armington & Sims. Steam pressure, 80 lbs.

Generators.—Five No. 32, Edison, belted direct from engines.

Roadbed.—25, 30, 40 and 56 pound T rail; 35, 45 and 63 pound girder. Six miles track length, paved. Railway company required to keep paving in order. Length of all tracks, 16 miles; street length, 10 miles. General condition, fair to good.

Grades.—Steepest, 9.25 per cent; length, 400 feet. General character of road, moderately heavy.

Cars.—Total number in equipment, 18 motor, 4 trail. Length 16 feet. Average number in daily use, 16 motor. Trail cars rarely used.

Annual Car Mileage, 724,000; daily average, 2,000; daily average per car, 125. Some cars regularly make 10 miles per hour including all stops.

Wages.—Conductors, 14 cents per hour; motor men, 16 cents; engineers and mechanics, 20 cents; laborers, 11 cents.

This road has a record of one car running for 155 consecutive days, covering about 17,050 miles, with no other repairs than new motor brushes, brake shoes and chains.

DETAILS OF OPERATING EXPENSES.

	Expenses per car mile. (Cents.)
Maintenance of road-bed and track	.67
Maintenance of line	.15
Maintenance of power plant:	
Repairs on engines and boilers	.110
Repairs on dynamos	.013
Miscellaneous repairs	.236— .36
Cost of power:	
Fuel (nut and slack, at $1.75 per ton)	.966
Wages of engineers and firemen	.373
Oil and waste	.154
Water	.069
Other supplies	.021—1.58
Maintenance of rolling stock:	
Repairs on motors (ex. gearing)	.166
Repairs on gearing and trolleys	.552
Repairs on car bodies and trucks	.110— .83
Transportation expenses:	
Wages of conductors and motor men	3.555
Wages starters, switchmen, track sweepers, etc	.110
Accidents to persons and property	.107
Cleaning and inspecting cars, oil, waste, etc	.207—3.98
General expenses:	
Salaries of officers and clerks	.649
Office expenses	.027
Insurance	.189— .87
Total	8.43

ROAD NUMBER THREE.

Boilers.—Eight H. T.—five 18 × 66, three 16 × 72.

Fuel.—R. o. m. at $2.68 per ton. Consumption, 12.2 pounds per car mile.

Engines.—Nine—five 125-h. p. Phœnix, two 100-h. p. Phœnix, two 125-h. p. Beck. Belted direct to generators. Steam pressure, 90 pounds.

* Including entire reconstruction of one and one-half miles of track with new rail.

Generators.—Nine—two No. 32 Edison, seven 80-h. p. Thomson-Houston.

Roadbed.—Thirty-five-pound tram, 45-pound T and girder. Four miles track length paved. Railway company keep paving in order. Length of all tracks, 51 miles; street length, 35 miles. In general good condition.

Grades.—Steepest, 8 per cent.; length, 800 feet. General character of road, heavy.

Cars.—Total number in equipment, 53 motor, 15 trail; 4 Westinghouse, 20 Edison, 10 30-h. p. T.-H., 19 20-h. p. T.-H. Average number in daily use, 50 motor.

Annual Car Mileage, 1,819,900; daily average, 5,027; daily average per car, 100.

Wages.—Conductors and motor men, $10.00 per week, 12 hours per day; engineers, $125 and $90 per month; mechanics, $2.50 and $2.75 per day; laborers, $1.25 per day.

DETAILS OF OPERATING EXPENSES.

	Expenses per car mile. (Cents.)	
Maintenance of roadbed and track		.95
Maintenance of line		.20
Maintenance of power plant:		
Repairs of engines, dynamos, etc		.39
Cost of power:		
Fuel (r. o. m. at $2.68 per ton)	1.643	
Wages of engineers and firemen	.425	
Oil, waste and other supplies	.204—	2.27
Maintenance of rolling stock:		
Repairs on motors (ex. gearing)	1.210	
Repairs on gearing, car bodies and trucks	.852	
Machine shops and mechanics	.943—	3.01
Transportation expenses:		
Wages of conductors and motor men	4.473	
Accidents to persons and property (insurance)	.190	
Cleaning and inspecting, oil, waste, etc., included in machine shops and mechanics		4.66
General expenses:		
Salaries of officers and clerks	.460	
Office expenses	.162	
Miscellaneous	.188—	.81
Total		12.29

ROAD NUMBER FOUR.

Boilers.—H. T., with Murphy furnace.

Fuel.—Slack, at $1.00 per ton. Consumption, 4.3 pounds per car mile.

Engines.—Three 200-h. p. and three 125-h. p. Armington & Sims, belted direct to generators. Steam pressure, 100 pounds.

Generators.—Six No. 32 and six No. 16. Edison.

Roadbed.—Sixty-six pound girder rail. All paved. Railway company pave and maintain 16 feet in width of street. Length of all tracks, 40 miles; street length, 19½ miles. In good condition.

Grades.—Steepest, 5 per cent.; length, 400 feet. General character of road, level.

Cars.—Total number in equipment, 85 motor, 140 trail. Length, 16 feet. Average number in use daily, 70 motor, 70 trail.

Annual Car Mileage.—4,625,636 miles; daily average, 12,776; daily average per car, 91.1.

Wages.—Motor men, $2.00 for 12 hours. Conductors, $1.75 for 12 hours first year, $1.90 after first year. Shop men, $1.50 to $3.00 for 10 hours.

DETAILS OF OPERATING EXPENSES.

	Expenses per car mile. (Cents.)	
Cost of power:		
Fuel	.218	
Wages of engineers and firemen	.152	
All station repairs and supplies	.111—	.48
Maintenance of rolling stock:		
Repairs on motors and gearing	.918	
Repairs on car bodies and trucks	.442—	1 36
All other operating expenses		6.96
Total		7.8

ROAD NUMBER FIVE.

Boilers.—H. T., two 78 × 16.

Fuel.—R. o. m. at $2.15 per ton. Consumption, 6.4 pounds per car mile.

Engines.—Ball; three 150 h. p. single high-speed. Steam pressure, 95 to 100.

Generators.—Six No. 32, belted direct from engines.

Roadbed.—Forty-five and 52 pound girder. Street length, 14 miles; length of all tracks, 15.5 miles. Seven miles track length paved. Company pave between tracks and maintain. In good condition.

Grades.—Steepest, 10 per cent.; length, 775 feet. General character of road, moderate.

Cars.—Total number in equipment, 52; 25 motor (20 double, 5 single). Length, 16 feet closed, 21 feet, 30 feet, 32 feet open. All single track. Average number in use daily, 18 motor.

Annual Car Mileage.—699,060; daily average per car, 106.4.

Wages.—Conductors and motor men, 15 cents per hour; engineers, $70 and $85 per month; mechanics, $2.00 to $2.25 per day; laborers, 15 cents per hour.

DETAILS OF OPERATING EXPENSES.

	Expenses per car mile. (Cents.)	
Maintenance of roadbed and track		.17
Maintenance of line		.21
Maintenance of power plant:		
Repairs on engines and boilers	.027	
Repairs on dynamos	.026	
Miscellaneous repairs	.037—	.09
Cost of power:		
Fuel (r. o. m. at $2.15 per ton)	.690	
Wages of engineers and firemen	.393	
Oil and waste	.058	
Water (at 10 cents per 1,000 gallons)	.054—	1.20
Maintenance of rolling stock:		
*Repairs on motors	2 086	
Repairs on car bodies and trucks	.239—	2.33
Transportation expenses:		
Wages of conductors and motor men	5.032	
*Cleaning and inspecting, and oil and waste for motors (see note below)		
Miscellaneous	.035—	5.07
General Expenses:		
Salaries and office expenses	.544	
Advertising and printing	.086	
Insurance	.071—	.70
†Incidental expenses		1.23
Total		11.00

*In the item of repairs on motors are included gearing, cleaning and inspecting, oil and waste for motors, and also the expense incurred in changing the motors from closed to open cars in the spring and back again in the fall.

†Under this head are included a large number of small items which should probably be distributed about *pro rata* under the seven other heads.

ROAD NUMBER SIX.

Length of road, four miles; grades, heavy; average number of cars in daily operation, five passenger, one freight; average daily mileage of passenger cars, 96.6.

	Oper. ex. per car mile. (Cents.)	
Maintenance of roadbed and track		.10
Maintenance of line		.06
Maintenance of power plant:		
Repairs on engines and boilers	.072	
Repairs on dynamos	.017	
Miscellaneous repairs	.007—	.10
Cost of power:		
Fuel	2.147	
Wages of engineers and firemen	.774	
Wages of dynamo tenders and mechanics	.100	
Oil and waste	.217	
Water	.294	
Other supplies	.232—	3.76
Maintenance of rolling stock:		
Repairs on motors	.410	
Repairs on car bodies and trucks	.176—	.59
Transportation expenses:		
Wages of conductors and motor men	3.653	
Wages of track sweepers, etc	.237	
Accidents to persons and property	.007	
Cleaning and inspecting cars	.826	
Oil, waste and other supplies	134	
Wages of freight hands	1.270—	6.13
General expenses:		
Salaries of officers and clerks	1.370	
Office expenses	.070	
Advertising and printing	.261	
Insurance	.168—	1.87
Total		12.61

The above are results for a period of nine months. Coal cost $3 per ton for r. o. m. and $3.80 for lump. Wages of conductors and motor men, 9 to 11 cents per hour. Water cost 20 cents per 1,000 gallons. In the above no account is taken of the mileage of the freight cars. The cost of operation per car per day, including freight cars, is $10.11. Deducting cost of operating freight cars entirely, cost of passenger cars alone is 11.20 cents per car mile. In the nine months the freight cars hauled 16,738,000 pounds of freight.

This road is not one of the six already referred to:

ROAD NO. 7.

Operating 18 miles by electricity and 4½ by horses.

ELECTRIC SYSTEM.

Boilers.—Babcock & Wilcox.

Fuel.—Three parts "pea and dust" (hard) to one part lump (soft). Average price, $2.23 per ton. Consumption, 4.7 pounds per car mile, costing .524 cents.

Engines.—One 400-h. p. Green, condensing, 50 to 55 pounds steam pressure, belted direct to three No. 32 Edison dynamos, and two 150-h. p. Corliss, condensing, 80 pounds steam pressure, belted to countershaft, thence to three No. 32 Edison dynamos.

Roadbed.—Johnson girder rail, 45, 56 and 63 pound. Length of all tracks, 18 miles; street lengths, 15 miles. All paved between tracks. Railroad company keep paving in order. Track in good condition.

Grades.—Steepest, 8.4 per cent.; length, 500 feet. General character of road moderate.

Cars.—36 closed, double motors, 16 and 20 feet long; 25 open, single motors, 16 feet. Average number in use daily, 19 closed, 9 open.

Car Mileage.—Total from April 1 to Oct. 1, 1891, 549,177. Daily average per car, 107.

Passengers Carried.—Total from April 1 to Oct. 1, 1891, 3,508,168.

Wages of conductors and motor men, $2 per day of 11 hours.

OPERATING EXPENSES, TAXES AND TOLLS.

	Ex. per car mile. (Cents.)
Maintenance of roadbed and track, based on experience of seven years at $900 per mile per annum	1.516
Maintenance of line, including material, wages of linemen and horse keeping	.569
Cost of power, including fuel, oil and waste, engineers and firemen, master mechanic, water, repairs to engines, boilers, station apparatus and buildings	1.304
Motor repairs, including material, wages superintendent and repair men, carpenter, blacksmith and machinist work	1.402
Wages of conductors and motor men	4.815
Sundry expenses, including starters, flagmen, foremen, watchmen, washing cars, sundry help, gas, coal, water, oil, repairs to car bodies and trucks by carpenters, blacksmiths and machinists	1.684
Extraordinary repairs, including repairing two burned cars, two dynamo armatures burned by lightning, $2,000 paid for exchange of 46 motor armatures, shaft repairs, and rent of extra station building	.725
Extraordinary horse expenses, including horses kept over and not used on horse road	.284
General officers, clerks and superintendents, less 20 per cent. charged to horse road	1.051
Legal expenses and damages, less 20 per cent., as above	.291
Insurance	.184
Property, dividend and capital taxes, and bridge rent and tolls	1.090
Total of all operating expenses, taxes and tolls	14.915

DEPRECIATION.

The yearly depreciation on cost of boilers, electric lines, motors and electrical and mechanical appliances connected therewith is estimated at 10 per cent. The yearly depreciation on engines, dynamos and appliances at 5 per cent. On this basis the total depreciation is 2.141 cents per car mile.

HORSE SYSTEM.

Car Mileage.—Total from April 1 to Oct. 1, 1891, 136,933, on 4½ miles of track.

OPERATING EXPENSES.

	Ex. per car mile. (Cents.)
Maintenance of roadbed and track, based on experience of seven years, at $500 per mile per annum	1.059
Power, including feed, shoeing, repairs to harness, depreciation of horses, barn men, etc	9.141
Conductors and drivers	7.806
Other items, including washing cars, foremen, watchmen, starters, gas, water, coal, oil, etc	1.464
General officers, clerks, superintendents, etc., 20 per cent. of total amount	1.054
Legal expenses and damages, 20 per cent., as above	.292
Insurance	.179
All taxes and bridge tolls and rents	.980
Total of all operating expenses, taxes and tolls	21.975

NOTE.—In justice to the horse system, it might be added that for the past two years the price of feed has been much above the general average.

COMPARATIVE SHOWING.

	Electric.	Horse.
Receipts per car mile	30.30	21.07
Operating expenses, taxes and tolls	14.92	21.98
Net earnings	15.38	

Statistics of Lightning in Germany.

Lightning casualty returns have been made in conformity with a German ministerial order, showing the extent to which the buildings belonging to or under subsidy from the State have, within the period from 1877 to 1886, been damaged by lightning. The number of buildings with regard to which returns were collected was 53,502, of which 22,682 were actual State property, and 30,820 were entitled to State subsidy for rebuilding or repair. Buildings were struck in 264 cases, or about five for every 1,000 buildings in ten years. Of the various classes of buildings the number struck per 1,000 of the period are as follows:—Elementary schools, 0.8; parochial houses, 1.4; revenue buildings, 1.7; prisons and penitentiaries, 3.4; forest rangers' houses, 7.2; churches, 8.2; court houses, 11.9; seminaries, 14.6; gymnasia, 15.4; university buildings, 24.1; domain buildings, 44.9; and horse-breeding establishments, 312.5. Those which are the property of the State are less subject to injury by lightning than those only under subsidy. Out of the 264 cases in which the lightning struck, 81, or not even one-third, resulted in a fire. The amount of injury wrought by lightning on the 53,502 houses coming within the scope of these statistics was £56,834, or £215 for each casualty, or 21s. per building in ten years, about 2s. per building per annum. The amount of injury done to domain and horse-breeding establishments was considerable, amounting to £42,000, or more than two-thirds of the total injury caused by lightning. It has been calculated, from the returns of sixty fire insurance companies of Germany, Austria and Switzerland, embracing the period from 1855 to 1877, that the danger from lightning has increased two and a half fold in those countries, during the period named. The danger is said to have increased three-fold in Germany within the last thirty years. The average loss sustained annually by Germany from this cause is computed at from six to eight millions of marks. Casualties have thus increased in the period of lightning conductor extension.

Financial Intelligence.

THE ELECTRICAL STOCK MARKET.

Chicago Quotations.—Col. S. G. Lynch, broker, 153 Monroe street, Chicago, furnishes quotations on telephone and electric light stocks as follows:

TELEPHONE STOCKS.

Chicago	$230@	$235	Cumberland	$60@	$62
Central Union	50@	51	Wisconsin	118@	120
Michigan	82@	83	Bell of Missouri	175@	180
Great Southern	30@	32	Iowa Union	20@	22
Colorado	34@	36	Missouri and Kansas	54@	56
Rocky Mountain Bell	40@	43			

ELECTRIC LIGHT STOCKS.

Chicago Arc Light and Power	$97@	$99	Chicago Edison Co	$145@	$150

The Closing Quotations of electric stocks on Saturday, Oct. 24 1891, in New York and Boston were:

Name of Stock.	Par.	Capitalization.	Bid.	Ask'd.
NEW YORK.				
Western Union Telegraph Co	100	86,200,000	82⅛	82⅜
American Telegraph & Cable	100	14,000,000	....	80
Central and South American	100	5,000,000	....	....
Mexican	100	2,000,000	....	....
Commercial Cable Co	100	7,716,000	....	....
Postal Telegraph Cable	100	5,000,000	28	33
Edison General Electric	100	15,000,000	98⅛	99½
Consolidated Electric Light	100	2,500,000	20	30
Edison Illuminating Co	100	4,500,000	80	81
United States Electric Light	100	1,500,000	20	25
Edison Illuminating Co., Brooklyn	100	750,000	76	80
" " " Boston	100	1,263,500	97½	102½
" " " Chicago	100	750,000	135	145
U. S. Illuminating Co	100	1,250,000	30	35
North American Phonograph Co	....	....	1	3
New York Phonograph Co	100	6,200,000	2½	4
BOSTON.				
Thomson-Houston Electric Co	25	6,000,000	49¼	49⅝
" " preferred	25	4,000,000	25	26
" " Series C	10	400,000	....	....
" " Series D	10	120,000	7¼	7⅛
" International Co	100	1,000,000	....	200
Thomson Welding Co	100	1,000,000	....	140
" European Welding Co	100	1,000,000	48	60
Ft. Wayne Electric Co	25	4,000,000	13	14
Westinghouse Electric Mfg. Co	50	5,000,000	13	13¾
Detroit Electric Works	....	....	8¾	....
Pettengill-Andrews Co	....	....	....	25¼
Telephone:				
American Bell	100	12,500,000	181	181½
Erie	100	4,800,000	45⅛	50
New England	100	10,304,600	50	....
Mexican	10	1,280,000	....	1.10
Tropical American	10	400,000	⅛	¾

NEW INCORPORATIONS.

Logansport, Ind.—The Logansport Electric Light and Power Company has been incorporated. Capital stock, $60,000. Incorporators and directors, R. T. McDonald, Joseph Seiter, V. E. Seiter, B. Rarison, E. J. Hathorne.

The Acme Light, Heat and Power Company, of Chicago, Ill., with a capital stock of $2,000,000, has been incorporated to furnish light, heat and power. Geo. S. Knapp, Jas. A. Turner and Simeon J. M. Bear are the organizers.

The Logansport Electric Light and Power Company, of Logansport, Ind., has been organized, with a capital stock of $60,000. The directors are R. T. McDonald, Joseph Leiter, Victor E. Leiter, Brainard Rorison and Ed. J. Hathorne.

The Glenwood Heights Company, of Charleston, W. Va., has been incorporated with a capital stock of $52,000, to maintain and operate electric lights, and furnish same for light, etc. John Alleman, P. E. Duffy, and L. A. Christy are the incorporators.

The W. D. Hyslop Electric Company, of Lafayette, Ind., with a capital stock of $10,000, has been formed to manufacture and sell electrical and surgical instruments, etc., etc. William D. Hyslop, R. H. McMullan and John B. Sherwood are the promoters.

The Pascagoula Ice Company, of Scranton, Mass., with a capital stock of $15,000, has been organized to manufacture electric lights, etc., furnishing cold storage, etc. L. T. Bell, Sr.; F. McArdle, F. P. Rives, John Foster and Ed. Bloomfield are the incorporators.

The Cumberland Electric Light Company (incorporated in West Virginia), of Pittsburgh, Pa., has been formed with a capital of $100,000, to manufacture, construct and operate all kinds of electrical apparatus for light and power, etc. Jas. S. Humbird, H. L. Childs, and F. S. Marr, are the organizers.

The Electro-Novelty Company, of 39 Exchange street, Pontaic, Me., has been incorporated with a capital stock of $50,000, to manufacture and deal in all kinds of electric novelties. Jos. H. Cupples, W. A. Connelly, John P. Cushing, Ed. C. Ramsdell, Lewis H. Rogers and Walter R. Kahaul are the incorporators.

The Alexander-Chamberlain Electric Company, of New York City, with a capital stock of $1,000, has been organized to prosecute the business of electrical engineering, the construction of electrical works, etc. Hugo Alexander, Harry Alexander, and Rudolph N. Chamberlain, all of New York City, are the incorporators.

The Spher-Electro Power and Development Company, of Portland, Me., has been formed, with a capital of $2,500,000, to manufacture and deal in machinery, apparatus and appliances of all kinds. The promoters are Aaron F. Smith, of Lynn; Chas. H. Tighe, of Peabody, and Orlando E. Lewis, of Boston, Mass.

The Bates & Blake Electric Railway Conduit Company, of Waterloo, Ia., has been formed to manufacture and sell the Bates & Blake Electric Railway Conduit and Trolley, also railway supplies in general. E. P. Caldwell, Jo. W. Bates, Jr.; Carlestine E. Blake, E. C. Blake, C. E. Hale, J. D. Caldwell and E. C. Platt are the promoters.

The Mott Visual Telegraph Company, of Jersey City, N. J., with a capital stock of $500,000, has been incorporated, to manufacture, construct, etc., and sell electrical bulletin instruments. W. A. Vail, C. H. Smith, both of Brooklyn, N. Y.; C. R. Ruex, B. Whitehorne, both of Montclair, N. J., and R. G. Brown, of New York, are the organizers.

The National Electroprise Company, of New Orleans, La., has been formed, with a capital stock of $250,000, to purchase and sell the electroprise and similar instruments in Ohio, Indiana, Illinois, Michigan, Wisconsin, Iowa, Missouri, Minnesota, North Dakota, South Dakota and Kansas. The promoters are E. C. Fenner, Robert Manson and Jno. C. Febiger.

The Mifflinburg Electric Light and Power Company, of Mifflinburg, Union County, Pa., has been formed, with a capital stock of $1,000, to supply light, heat and power, by means of electricity, to the public at Mifflinburg, Pa. Jas. H. Shodgrass, Jno. A. Beard, Aaron Klose, Wm. A. Ewing and Robt. E. Snodgrass, all of Mifflinburg, are the incorporators.

The Crouch Houston Electric and Manufacturing Company, of Eugene, Ore., has been organized with a capital stock of $1,000,000, to purchase, sell, rent and dispose of any letters patent and inventions heretofore patented to Frank J. Crouch, especially his invention called the Crouch safety dynamo. Frank J. Crouch, Eugene Ore, C. P. Houston and W. L. Houston are the organizers.

AFFAIRS OF THE COMPANIES.

The Thomson-Houston Company, of Boston, has declared a dividend of $1 per share, payable Nov. 14, to stockholders of record Nov. 4.

Birmingham, Ala.—The annual meeting of the Consolidated Electric Light Company has been called for Nov. 10, for the purpose of electing a board of directors, etc. J. F. B. Jackson is president of the company.

An Assignment has been made by the Continental Electric Construction Company, of Chicago, Ill, in favor of Wm. Forbush, of South Evanston, Ill. The company was recently organized, and had headquarters at 1,118 Chamber of Commerce building. Its assets are scheduled at $5,000; liabilities, $12,000.

Albany, N. Y.—At a special meeting of the newly elected board of directors of the Albany railway, the following officers were unanimously elected for the ensuing year: President, Robert C. Pruyn; vice-president, Anthony N. Brady; secretary, James McCredie; treasurer and general manager, John W. McNamara.

Burlington, Pa.—At its recent annual meeting the Burlington Electric Light and Power Company elected the following officers: President, R. Frank Wood; vice-president, G. W. Lewis; secretary, Howard Flanders; treasurer, Thomas Daniels; directors, J. Frank Budd, George A. Allison, James O. Glasgow, H. E. Packer, Nathan Haines.

The annual meeting of the stockholders of the Quincy & Boston Electric Street Railway, of Quincy, Mass., was held recently and the following officers elected; President, John R. Graham; secretary and treasurer, Fred H. Smith; directors, John R. Graham Roger H. Wilde, Winthrop Coffin, John A. Duggan, Arthur Burnham, Thos. H. McDonnell, Wm. A. Hodges, Josiah Quincy and John F. Merrill.

Albany, N. Y.—The stockholders of the Commercial Union Telegraph Company held their annual meeting last week at the office of the company, and elected the following directors for the coming year: Henry Russell, Henry L. Smith, Clifford D. Gregory, Charles E. Arnold and Edward J. Slattery. Subsequently at a meeting of the board of directors the old officers were re-elected for the ensuing year: President, Henry Russell; vice-president, Henry L. Smith; general manager, Charles E. Arnold; secretary and treasurer, Edward J. Slattery. A semi-annual dividend of 3 per cent. on the stock was declared. The annual report submitted showed that the company had earned during the past six months $20,000 in gross more than during the corresponding six months of 1890.

Special Correspondence.

NEW YORK NOTES.

OFFICE OF THE ELECTRICAL WORLD,
167-177 TIMES BUILDING, NEW YORK, Oct. 26, 1891.

The Phoenix Glass Company will be located at 42 Murray street after Nov. 1.

The L. J. Wing Company, 126 Liberty street, has taken the agency for the Barnitt motor for the United States.

Mrs. Goodyear, widow of the late M. W. Goodyear, has leased and refitted the "Boston," 153 West Fourteenth street, this city, and is prepared to furnish board and rooms to electricians and others at reasonable rates.

H. W. Seller & Co. have recently opened an office in the Electrical Exchange building, Room 319. Mr. H. W. Seller was formerly connected with the Babcock & Wilcox Company, and is well known as a designer of steam plants. The company are manufacturers of the new Seller water tube boiler.

Mr. Newton L. Schloss, of Thomas H. Dallett & Co., announces that his company is bringing out a combination electric lighting plant made up of a Triumph compound engine coupled direct to a Billberg dynamo. These plants will be built varying in capacity from 15 lights to 1,200. Mr. Schloss' connection with the Edison company and his work in the design of similar plants to those mentioned above is a sufficient guarantee that the apparatus which will be placed upon the market will be well designed both mechanically and electrically. L. H. H.

NEW ENGLAND NOTES.

BRANCH OFFICE OF THE ELECTRICAL WORLD,
Room 28, Hathaway Building, 620 Atlantic Ave.,
BOSTON, Mass., Oct. 21, 1891.

Franklin, N. H., is to have the electric light. The Edison system will be used.

The Leicester & Spencer Electric Railway has carried 166,000 passengers since its opening in August.

The Pettingell-Andrews Company reports business as exceptionally good in its various departments.

President Henry B. Cram, of the Bernstein Electric Company, has almost entirely recovered from his recent illness.

The Biddeford, Saco & Old Orchard Electric Railway is now under construction and is being pushed as rapidly as possible.

The Watertown Machine Shops are receiving many orders for the Prior Insulating Joint, and it is proving its popularity by repeated orders.

Mr. A. C. Shaw, New England manager of the *Electrical Engineer*, sailed for Europe on Wednesday last for a short visit to his parents in Edinburgh.

Mr. A. O. Smith, of the Eastern Electric Supply Company, who has been seriously ill, has recovered so as to be at the office a short time each day.

The National Electric Company, of Boston, reports a largely increasing demand for its non-induction wire for telephone, fire alarm and police service wires.

The Clemons Electrical Manufacturing Company, of Attleboro, has the entire contract for building and equipping the Interstate Street Railway lines.

A. O. Smith, secretary and treasurer of the Eastern Electric Supply Company, is confined to his bed by a serious cold. His many friends will wish for his early recovery.

The Franklin Battery Company, of Boston, is bringing out a new battery. Mr. J. P. Barrett, for many years with the well-known firm of Holtzer, Cabot & Co., is the inventor.

The Economic Electric Company, owing to the increase in the sales of its popular lamp, has put in 22 new pumps which will enable it to keep more closely to its orders than heretofore.

The Simplex Motor Company, 113 Devonshire street, Boston, has issued a very attractive prospectus fully covering the points of this new departure in electric motor construction.

Mr. Lawrence J. Webster, of the Massachusetts Electrical Engineering Company, sailed this week on the Umbria for an extended business trip of several months in England and Germany.

George W. Payne & Son, Pawtucket, manufacturers of the Payne braiders and spools for covering wire, report business in this line as being very brisk and the prospects for future business extremely good.

The Boston Gear Works, 31 Hartford street, are very busy even for this season, but this is accounted for by the superior work which they are turning out and the promptness and care used in filling orders.

The Union Glass Company, of Boston, is unusually busy this fall. The quality of its globes makes them the most economical for use in windy weather. Among the specialties which the company is introducing are half silvered arc globes for lighting show windows, bill boards, etc.

The New England Butt Company, of Providence, R. I., is receiving many foreign orders this season, and this, with its increasing home trade, makes business pretty brisk. With the new wire works continually being opened and the old ones increasing their plants there would seem to be no reason why it should not continue to increase indefinitely.

The Ellis Lubricator Company, 161 High street, Boston, is making a fine line of cylinder bearing and valve sight feed oil cups especially of interest to the electrical trade where a reliable cup is needed. That they are appreciated is attested by the many prominent electric companies now using them as well as railway and steamship companies and others.

Mr. Charles A. Clark, formerly manager of the firm of B. S. Hale & Sons, wire manufacturers at Malden previous to its absorption by the Thomson-Houston Company, has accepted a position with the Electrical Specialty Company, of Pawtucket, R. I., selling its well known specialties. The Electrical Specialty Company is to be congratulated on this acquisition to its force.

The Mason Regulator Company's business continues to increase each month over any previous month and notwithstanding the increase in facilities already made the company has found it necessary to materially enlarge its plant in the near future. Many of the most conservative corporations in the country have adopted the apparatus manufactured by this company, including the Pennsylvania and the Philadelphia and Reading railways.

C. A. B.

WESTERN NOTES.

BRANCH OFFICE OF THE ELECTRICAL WORLD,
465 The Rookery, CHICAGO, Oct. 24, 1891.

Mr. Clark Sintz, of Springfield, O., is in the market with a new type of gas engine remarkable for its simplicity.

Mr. Thomas Appleton, 505 The Rialto, Chicago, has completed the plans for an extensive power house and also for a large manufacturing establishment.

Messrs. Jackson & Fitzpatrick, of Crystal Falls, Mich., have opened an electrical supply and construction house on Third street in that progressive mining town.

The Chicago Belting Company, Randolph and Canal streets, Chicago, has recently shipped several large belts to electrical stations and reports an unusually good fall business.

Mr. F. H. Leonard, general manager of the Electrical Engineering and Supply Company, Syracuse, N. Y., is a welcome visitor in Chicago this week, and is having quite a successful trip in the West.

Col. J. H. Shay, of the Charles Munson Belting Company, Chicago, secured the order for increase in belting from the Jacksonville (Ill.) Gas Light and Coke Company, and says he was royally entertained there.

Mr. Herbert Wadsworth, western manager of the Excelsior Electric Company, of New York, among other sales this past week closed contracts for two 50-light and one 100-light Excelsior arc dynamo with double lamps.

The Knapp Electrical Works, Franklin street, Chicago, have secured the services of Mr. H. M. Underwood, formerly of the Interior Conduit and Insulation Company, as general sales agent. Mr. Underwood will push the sales of safety insulated wires.

Mr. George E. Gale, chief accountant of the Excelsior Electric Company, of New York, accompanied by Mrs. Gale, visited Jackson Park and inspected the World's Fair site this week. Mr. and Mrs. Gale are on their bridal tour, and are now temporarily stopping in Chicago as the guests of Mr. and Mrs. Herbert Wadsworth.

Mr. H. K. Gilman, No. 205 South Canal street, Chicago, has arranged to send one of a set of suitable and interesting illustrated works, comprising from 100 to 320 pages, to every one interested in the practical application of electricity, on receipt of a letter or postal stating the exact line of business he is in and the address in full.

Mr. W. J. Pilley, of the Eastern Electrical Supply Company, of Boston, has opened in Chicago a Western office, from which point the entire West can be covered. Mr. Pilley secured some large orders in several of the cities at which he stopped en route to Chicago, and will at once visit the cities to the west of the World's Fair city.

Mr. Murray C. Chase, the hard rubber specialty manufacturer of Chicago, is rapidly turning out a lot of street railway specialties in hard rubber, and has been compelled to increase his force by the press of business. Mr. Chase manufactures hard rubber specialties to order only and has every facility at hand to turn the work out quickly.

The Acme Safety Emery Wheel Company, Fort and Beaubien streets, Detroit, Mich., is supplying manufacturing and repair shops with its safety wheels, in which the best of Turkish emery and Carolina corundum is dove-tailed into and cemented on the metal flanges of an iron center which prevents the wheels from flying if broken by accident or otherwise. This safety device also strengthens the wheels so that they are not liable to break from centrifugal strain.

The Illinois Electric Material Company, 158 Fifth avenue, Chicago, has recently added a line of batteries and bells, and is more than pleased with the excellent results reported by customers to whom it has sold the "Fibrous" dry battery. To prove the efficiency of the battery to a customer desiring one for nearly continuous work, a cell was placed in circuit with a three-inch wood box bell at noon on Oct. 6, and the bell has rung constantly since that time, and is still ringing, though 17 days have passed. One feature about this battery is that the cell is not sealed, and thus, it is claimed, cannot "short circuit" within itself.

Mr. R. Humffreys-Roberts, secretary and manager of the Fontain Crossing Company, Detroit, Mich., came over to Chicago last week and participated as one of the Chicago eleven in the cricket games played by the Gentlemen of England, Lord Hawke's team, and the Chicago Cricket Club. Various entertainments were tendered the visitors, including receptions, banquets, theatre parties and luncheons, and on Monday the English team left for Toronto. Mr. Humffreys-Roberts has opened a branch office in The Rookery, and proposes to secure some of the profitable isolated lighting work that is so plentiful in Chicago, owing to the large number of new buildings now being constructed.

Iowa Electric Club.—A meeting of gentlemen interested in electric light stations met in Cedar Rapids, Ia., recently for the purpose of organizing an electric club for the State. The Iowa Electric Club was organized, a constitution and by-laws adopted, and the following officers elected: W. R. Daum, of Ottumwa, president; H. M. Vaughan, of Newton, vice-president; C. H. Brampton, of Cedar Rapids, secretary, and J. A. Colby, of the Des Moines Edison company, treasurer. The executive committee is composed of the president and vice-president and Messrs. T. L. Seevers, of Marshalltown; L. L. Kellogg, of Sioux City, and C. A. Jones, of Independence. It was voted to hold the next meeting at Spirit Lake, Ia., in July, 1892. F. DE L.

KANSAS CITY, Mo., Oct. 23, 1891.

Aurora, Mo., is putting in one 45 and one 30 arc plant, Thomson-Houston system.

Mr. C. S. Rusling, representing the Thomson-Houston company at Chicago, was in the city recently.

Mr. P. C. Ackerman, New York agent of the American Electric Works, is among recent arrivals in the city.

Mr. J. H. Rhotchamel, president of the Columbia Incandescent Lamp Company, St. Louis, Mo., is in the city.

Mr. F. H. Leonard, of the Electric Engineering and Supply Company, Syracuse, N. Y., was in the city the past week.

The Great Western Manufacturing Company, of Leavenworth, Kan., has recently put in 100 new incandescent lamps.

Mr. F. H. Corthell, patentee of the Corthell adjustable extension for electric lamps, has been exhibiting his new system here.

The Haskell University, at Lawrence, Kan., has made arrangements to put in a complete incandescent plant. The work of wiring and installing the plant will be done by the students, and the operating of the plant will also be in their hands. H. D. E.

SOUTHERN NOTES.

NORFOLK, Oct. 21, 1891.

Velasco, Tex.—An electric light plant, it is stated, has been put in the Hotel Velasco.

Sherman, Tex.—An electric light plant has been put in by the Sherman Seamless Bay Company.

Dublin, Ga.—It is reported that an electric light plant has recently been installed and is now in operation.

Hopkinsville, Ky.—It is reported that the Thomson-Houston Electric Company will erect an electric lighting plant.

Lenoir, Tenn.—It is stated that an electric lighting plant is to be installed in the flour mill of Dempster & Plummer.

Monroe, La.—The City Council has received a proposition from W. A. Bright for the erection of an electric light plant.

Anniston, Ala.—The Anniston Street Railway Company has been reorganized, and will change to an electrical system.

Chattanooga, Tenn.—An electrical street railway will be built to Cameron Hill, by the Chattanooga Water and Electrical Company.

Grafton, W. Va.—The Grafton Gas and Electric Light Company will consolidate with the Grafton Electric Light, Heat and Power Company and increase its capital stock.

Chattanooga, Tenn.—The St. Elmo division of the Chattanooga Electric Street Railway Company will be extended to Blowing Spring. The company will issue $250,000 of bonds for improving its system.

Leesburg, Fla.—The Southside Telephone Company has been incorporated, for the purpose of constructing a telephone line from Leesburg to Yallaka. Capital stock, $7,000. Incorporators: A. J. Phares, president; J. F. Richmond, vice-president; W. T. Johns, secretary.

Franklin, Va.—The Town Council has decided to establish an electric light system. A plant will be installed of sufficient capacity to furnish arc lights for the streets, and to manufactories with the exception of the Camp Manufacturing Company, which is putting in an electrical plant of its own. It is not yet decided what

system will be adopted. The town will borrow the necessary funds, by issuing bonds.

NORFOLK, Va., Oct. 23, 1891.

St. Augustine, Fla.—The Alcazar Hotel will put in an electric light plant at once.

Knoxville, Tenn.—The electric railway company will extend its lines to Arlington.

Wilkesboro, N. C.—A telephone line will be built from Wilkesboro to Jefferson by R. A. Burroughs.

Bardstown, Ky.—A stock company is reported as organizing for the erection of an electric light plant.

Little Rock, Ark.—The street railway company is now extending its electrical lines to the extreme east of the city.

Monroe, N. C.—A $25,000 electric light plant and ice factory will be built by a company of Chattanooga capitalists.

Louisville, Ky.—The contract for building the Louisville Electrical Street Railway has been awarded to Jacob Park.

Knoxville, Tenn.—Another electric street railway is to be built. Work will commence about the 1st of January.

Anderson, S. C.—An electrical street railway is to be constructed by the Anderson Electric Light and Power Company.

Sherman, Tex.—The City Council has authorized the city railway to change its motive power to the electric system.

Woodruff's, S. C.—A telephone company has been incorporated by F. M. Sexton, J. B. Kilgore, J. H. Kirby and others.

Portsmouth, Ky.—It is reported that a company has been organized for the purpose of constructing an electrical street railway.

Cleveland, Tenn.—The new water-works will be operated in connection with an ice factory and electric light plant shortly to be erected.

Enterprise, Miss.—An electric light plant will be constructed to light the city, put in by the Enterprise Manufacturing and Development Company.

Charlotte, N. C.—A company will, it is stated, supply the city with electric lights and power for all purposes, by developing the water power at Horseshoe Bend, on the Catawba River.

Houston, Tex.—A charter has been obtained by the Houston Rapid Transit Company, and a contract will be let for constructing a 15-mile electric street railway. The capital stock is $300,000.

De Land, Fla.—The ice factory and electric light plant is to be changed from the arc system to the Edison incandescent system. It is reported that the Volusia County Bank will operate these enterprises.

Baltimore, Md.—A syndicate has been formed for the purpose of buying lands lying along the Western Maryland Railroad near Glyndon, and improving them by establishing on them electric light plants, water-work systems, etc. The capital stock is $500,000, and the company is known as the Western Maryland Railroad Land and Improvement Company.

WASHINGTON, D. C., Oct. 24, 1891.

Telephone Patent Cases.—A number of important telephone patent contest cases, which have been pending in the Patent Office for years, will be heard by the Commissioner of Patents during the present month.

The New Mexican Tariff.—The Bureau of American Republics, in this city, is informed that in the new Mexican tariff, which goes into effect Nov. 1, the following commodities, among others, have been added to the free list: Insulators for telegraph and telephone purposes, batteries and lightning rods.

The Graphophone Company.—The annual meeting of the American Graphophone Company was held at Harper's Ferry, W. Va., recently. The annual reports were presented, and the following gentlemen elected directors for the ensuing year: Chas. J. Bell, James G. Payne, Edward D. Easton, Andrew Devine, John H. White, Robert O. Holtzman and James A. Bates.

New York's Electrocution Law.—The New York Electrocution law came before the United States Supreme Court last week on a motion made by Attorney General Taber, of New York, to dismiss, affirm or advance the cases of Charles McElvaine and Nicolo Trezza, condemned murderers, who are awaiting death by the electrical current. Judge McCown, of New York, denied a writ of habeas corpus in the cases of the two men, and from this decision an appeal was granted to the Supreme Court. In his brief of the case filed in the Supreme Court, Mr. Curtis, council for McElvaine, bases his plea principally on the contention that the clause in the electrocution law prohibiting the publication of the details of an execution is a restraint of the liberty of the press granted by the Constitution, and that, therefore, the law is unconstitutional. The court took Mr. Taber's motion under advisement.

An Electric Light Permit.—During the early part of this month the United States Electric Lighting Company requested the commissioners to give them authority to build a new line of conduit from Seventeenth street along the south side of Pennsylvania avenue to Twentieth street. The law prescribes that the commissioners "shall not permit the additional construction of more than five miles of conduits or subways in aggregate length for electric lighting purposes; this to apply to all permits heretofore granted under existing law, but not to apply to necessary street or house connections for electric service." The United States Electric Lighting Company has a conduit on the north side of Pennsylvania avenue between Seventeenth and Twentieth streets, northwest, there being no conduit on the south side of said avenue between the points named. A question arose as to the power of the commissioners to grant the permission, and the attorney for the District was called upon at the request of Capt. Lusk to render an opinion on the case. This he has done, holding that the company has the right to make, and the residents along the avenue, on both sides thereof, to enjoy this electric service, and that the whole matter is a question of prudent administration to be solved by the commissioners. If in their judgment such necessity exists he sees no legal obstacle in the way of granting the proper permit for that purpose. Capt. Lusk has recommended that the permit be granted, and the matter will come up for consideration at the next session of the board of commissioners.

NORFOLK, Va., Oct. 24, 1891.

Newport, Ky.—An electric light plant has recently been put in by Wadsworth & Co.

Camden, Ark.—The capital stock of the Camden Electric Light Company will be increased.

Wilkesboro, N. C.—A telephone line will be constructed to Jefferson by R. A. Burroughs.

Lynchburg, Va.—A new dynamo will be put into the plant of the Lynchburg Street Railway Company.

Montgomery, Ala.—A Thomson-Houston arc light plant is being put in by the Montgomery Light Company.

Brenham, Tex.—Capitalists from Nebraska are investigating, with a view of establishing an electric light plant.

Bartow, Fla.—The Tube Well Company has received a franchise for an electric light plant, also a complete system of water-works.

Wheeling, W. Va.—The Wheeling Electrical Company's electrical plant has been purchased by the Wheeling Railway Company.

Towson, Md.—The county commissioners have been applied to by the Electric Traction System Company, of Baltimore, for authority to construct on Roland avenue their underground electrical railway system.

Decherd, Tenn.—An electrical street railroad is under contemplation by M. M. Bright & Co. This road will be three miles in length.

Atlanta, Ga.—It is stated that Atlanta capitalists will erect an electric light plant, to be operated by water-power, and transmitted to the city.

Cookeville, S. C.—A telephone line, it is reported, will be constructed from Cookeville to Lebanon by the Cumberland Telephone Company.

Hopkinsville, Ky.—A franchise has been granted to build the electrical railroads, lately mentioned. M. H. Garriety and others are interested.

Wellsburg, W. Va.—A new Edison dynamo will shortly be put in the electric light plant of the Wellsburg Electric Light, Heat and Power Company.

Atlanta, Ga.—A charter has been granted to the Atlanta, Hopeville & Manchester Railroad Company to build an electrical railroad from Atlanta to Manchester and Hopeville.

Brenham, Tex.—Mr. Miller, of Houston, has received the contract for the installation of an electric light plant at the cotton compress of the McFadden Compress Company.

Buena Vista, Va.—A new automatic engine and a new dynamo have been put into the plant of the Buena Vista Electric Light Company and the capacity of the plant increased.

Rome, Ga.—The Rome Street Railway Company has sold its entire interest to a Boston syndicate, who will greatly improve and extend the line and change to an electrical system.

Velasco, Tex.—It is reported that a telephone line is under contemplation from Velasco to Houston by way of Alvin. J. P. Wilson and others, of Independence, are interested.

Shelby, N. C.—It is reported that a company has been organized by C. W. Gallagher, of Baltimore, for the purpose of building an electrical railroad from Shelby to Cleveland Springs.

Richmond, Va.—The work of changing from steam to electricity, it is stated, will shortly be commenced on the narrow gauge railway of the Seven Pines Railway Company. This line is seven miles in length.

Athens, Ga.—An electric light plant is to be erected by Atlanta capitalists. They have made a proposition to the owners of Barnett Shoals, near Athens, for the use of 10,000 h. p., with which they will convey power to the city.

Baltimore, Md.—The Baltimore County Electric Construction Company has been incorporated for the purpose of building telegraph lines, and manufacturing and dealing in electrical supplies. The capital stock is $75,000. V. N. B.

CANADIAN NOTES.

OTTAWA, Oct. 24, 1891.

Summerside, P. E. I.—This town is considering an electric light service.

Vancouver, B. C.—The Westminster and Vancouver electric tramway line is now completed.

Victoria, B. C.—A new and powerful engine for the Electric Tramway and Lighting Company has been shipped from Galt.

Lindsay, Ont.—Thursday evening last the Edison incandescent plant, introduced by A. W. Parkins & Sons, started work, with a capacity of 400 lights.

Kentville, N. S.—This town is moving in the direction of securing the electric light. A company has been formed with a capital of $10,000 for the purpose.

Peterborough, Ont.—The Auburn Woolen Mills Company has placed with the Edison General Electric Company an order for a complete plant for lighting the mill and premises by electricity.

Ottawa, Ont.—The Chaudière Electric Light and Power Company booked three orders for electric motors recently, from Bannerman and Powers, and from Geo. Low and P. Latour, for motors of 12, 6 and 3 h. p. respectively.

Montreal, Can.—Mr. W. J. Camp, chief electrician of the Canadian Pacific Railway telegraph system at Montreal, accompanied by Mrs. Camp, who have been on an extended tour of cities of the Pacific coast, returned to the city from the West recently.

St. John, N. B.—Mr. E. L. Barr, assistant general manager of the Edison Electric Company, of the Canadian district, and H. W. Darling, president of the Canadian Bank of Commerce, Toronto, are on an inspection trip of the electrical appliances in the maritime provinces.

Ottawa, Ont.—Mr. A. A. Dion, who recently resigned his position as chief electrician of the Intercolonial Railway, has arrived in the city and assumed charge as manager for Ahearn & Sopher. Mr. Dion will also succeed Mr. W. Scott as secretary and treasurer of the Chaudière Electric Light and Power Company.

St. Catharines, Ont.—A syndicate has submitted an offer to supply this town with an electric light plant, including circuit, dynamos and lamps capable of furnishing 70 arc lamps, 2,000 nominal c. p., in consideration of receiving the contract of lighting the city for a period of five years at a rate of 28 cents per night during that period, the same to be handed over to the corporation for the sum of $4,000 payable in five years without interest.

Morrisburg, Ont.—The Town Council has granted the privilege of putting up electric light poles and wires on the streets of that place to the Reliance Electric Light Company of Waterford; the prices to be charged citizens to be not more than 15 cents per night for each 1,500-c. p. arc light, 5 cents per night for each 50 c. p., and 1½ cents per night for each 16-c. p. light to run from sunset to midnight, and as much longer as desired at the same proportion of cost.

Port Arthur, Ont.—At a meeting of the council recently a tender from the Edison company was recommended to be accepted for the supplying of the plant of an electric street railway, provided the company would accept the town bonds at 85, and 4 per cent. The tender price was $29,530, which includes the supplying of all electrical apparatus, the furnishing and setting up of a boiler and engine of 150 h. p., the erection of poles, stringing of wire, laying of rails, etc.

Ottawa, Ont.—The electric railway company proposes to run its cars this winter if practicable. Recently Superintendent Hutchison purchased from Lewis & Fowler, of New York, an electric snow sweeper, which members of the company state will do all that will be required, in the way of cleaning the snow and ice off the track. The snow-sweeper, the directors state, worked satisfactorily last winter in Bangor, Me.; Utica and Minneapolis, where the climate is similar to that of this city.

ENGLISH NOTES.

LONDON, Oct. 14, 1891.

The City of Dublin, Ireland, has voted £50,000, or $250,000, for the purpose of erecting a corporation electric light plant. The contract for the plant has been awarded to the Electric Engineering Company, of Ireland, of which Mr. Arthur E. Porte is chief engineer.

Sims-Edison Torpedo.—An attempt is being made to float a company to buy the Sims-Edison torpedo patents, but it seems very unlikely that it will be taken up. The absurd price of £150,000 is asked, and there seems to be nothing but a patent to sell. A number of ammunition and similar companies have turned out very badly, including the Maxim-Nordenfelt and Hotchkiss. The directors are concerned with several electrical concerns which are in no very brilliant condition.

The Westminster Electric Supply Company.—Under the able management of Prof. Kennedy this company is prospering and may shortly rival the St. James and Pall Mall company, which has the best district perhaps in the world, and which is about to build another station to the north of "club land." The Westminster Company is just now changing over to the three-wire system. The mains have been laid from the first, but the demand has only of late necessitated this arrangement.

Frankfort Exhibition.—The general feeling of those who visited this exhibition is difficult to get at. Some engineers think that the three-phase transmission experiment is of immense commercial importance, and others regard it as a rather sensational demonstration. Mr. Brown himself thinks that the use of three currents introduced additional difficulties rather than assistance, and was only of use for starting. No one thinks it likely that three-phase currents will be supplied for central stations, and they are regarded as only useful for separate plants.

Utilization of Water Power.—A number of schemes are being proposed on the Continent for supplying power from waterfalls, and several important plants have recently been started. A paper mill at Wolfegg, in Wurtemburg, is driven by 80 h. p. and it is probable that a 600-h. p. plant will be put down at St. Lorenzen, in Austria, to transmit power to works 18 miles distant. A 1,200-h. p. plant is proposed for Herisan, in Switzerland. A number of towns in England and Scotland are waking up to the fact that they have water power at their disposal, and Inverness, Aberdeen, Bristol and other places are obtaining advice from experts on this subject. The Yorkshire seat of the Marquis of Ripon has been provided with a turbine running 300 lights.

The Brush Electrical Engineering Company.—This company held its second annual meeting on Friday last, and the chairman, the Duke of Marlborough, was able to give an excellent account of its position. He recalled the establishment of the old Anglo-American Brush company and of the prevailing idea, in 1879, that electric light was going to sweep away the gas companies, as the Brush company held patents which were considered to be very valuable, which were sold for very large sums. The company earned enormous dividends, in one year a dividend of 100 per cent. being paid. In a very few years the company got into difficulties, the chairman, Sir Henry Tyler, resigned, and Lord Thurlow took his place. Lord Thurlow was very largely instrumental in getting the electric lighting act amended, and, though the beneficial effect is now being felt, there were five years of great depression. In 1884 a reconstruction of the company became necessary, and the present one was ultimately formed; large manufacturing premises were leased, and now the company is doing a large business, a gross profit of £39,915 having been made this year. The large share which they have in city lighting will largely increase the business.

Answers to Correspondents.

Questions to be answered in this column must be of general electrical interest, and must be accompanied by real name and address as a guarantee of good faith. No notice will be taken of questions regarding apparatus unless enough details are given to permit a definite answer, and no dynamo or motor designing will be done.

Fuses.—(1) Should the station fuses for the primary lines of a 1,000-volt alternating dynamo be much larger than sufficient to carry the full load of the machine, and also how much larger? (2) Does the blowing of the smaller fuses in a lighting or power circuit tend to weaken the carrying capacity of the heavier fuses behind them when such fuses have been blown by short circuits?

V. P. C.

(1) The station fuses should have a capacity quite up to the full load of your machine, and as this usually represents the load which can be handled continuously the fuses may be somewhat larger, not more than 25 per cent. in excess probably at the very outside. You really have no use for fuses larger than those representing an amount of current a few per cent. greater than the full load of lamps connected. The carrying capacity of any given fuse is very nearly constant, whatever happens to other fuses in the circuit.

Lightning Arresters.—In an alternating system is it advisable to use lightning arresters on the secondary circuits when they are longer than 500 feet or so? (2) Would an arrester consisting simply of an air gap with no means of blowing out the arc formed by the lightning discharge be adequate? Should the width of this gap be equal to the gap in the arresters on the primaries? (3) Would winding the primary mains into helices just before they enter the transformer tend to keep the lightning from passing through the transformer into the secondaries?

J. B.

(1) It might occasionally save a transformer but is hardly a necessity. Every lightning arrester should be provided with means for putting out the arc that may sometimes be formed through it. In the case you mention the secondary fuse itself would probably be sufficient. The smaller the air gap in any case the better. Such helices would have no perceptible effect on the lightning discharge, or anything else, unless the number of turns is very much larger than you would ever care to make.

Incandescent Lamps.—We are desirous of placing 20 100-volt incandescent lamps of 32 c. p. across a 2,000 alternating circuit five miles from our plant. We do not care to run an extra loop this distance. We propose using a series automatic socket, and desire to do away with shunt boxes. Can you recommend some device by which we can throw in automatically an equivalent resistance or choking coil in the event of the burning out of one or more lamps?

M. D.

We judge that your circuit is an ordinary incandescent alternating circuit; if so, a 20-light transformer put across your lines with incandescent lamps running in parallel off the secondary is possibly the best solution of the difficulty. If you have any difficulty in obtaining a transformer to reduce the potential to 100 volts, Mr. William Stanley, Jr., Pittsfield, Mass., or some other maker of special alternating apparatus, could provide the proper transformer. If your alternating circuit is a constant current one, you can use 32 c. p. series lamps such as are run on direct current arc circuits.

News of the Week.

THE ELECTRIC LIGHT.

Dundee, Mich.—The town wants electric lights.

Velasco, Tex.—The town is agitating electric lighting.

Shippensburg, Pa.—The town is now lighted by electric lights.

Frankfort, Mich.—The electric lighting question is being agitated.

Grand Haven, Mich.—The town will be lighted by electricity early in November.

Zanesville, O.—The plant of the Zanesville Electric Light Company is to be enlarged.

Washington, Ia.—An electric light plant is being put in by D. W. Hunt, of Oskaloosa.

Albia, Ia.—D. W. Hunt, of Oskaloosa, Ia., is to establish an electric light plant here.

Rock Ledge, Fla.—An electric lighting plant is being installed in the Hotel Indian River.

Monroeville, O.—The electric lighting question is being considered by interested citizens.

Wheeling, W. Va.—It is expected that the city will be entirely lighted by electricity by Jan. 1.

Haywards, Cal.—Work on the electric light plant is being rapidly pushed to completion.

San Antonio, Tex.—The Alamo Electric Company has been placed in the hands of a receiver.

Kalamazoo, Mich.—The new Y. M. C. A. building is to be lighted by 300 incandescent lights.

Summerside, Prince Edward Island.—An electric lighting plant will soon be in operation.

St. Clairsville, O.—It is expected that the electric lighting plant will be in operation by Dec. 1.

Indiana, Pa.—It is expected that the new electric light plant will be ready for operation by Nov. 1.

Perry, Ia.—A franchise has been granted to J. M. Bunker and others to erect an electric light plant.

Ypsilanti, Mich.—The Ypsilanti electric company expects to have its plant in operation by Nov. 15.

Plymouth, Mich.—The J. A. Dubuar Manufacturing Company will light its shops with electric light.

Little Falls, N. Y.—W. H. White & Co. will add a new boiler and engine to their electric light plant.

Morrisville, N. J.—The Vulcanite Rubber Works is considering lighting the plant with electricity.

Stillwater, N. Y.—The village trustees are to consider the matter of lighting the village by electricity.

Del Rio, Tex.—The electric light plant is proving a success and is yielding a good income to the owners.

Chester, Pa.—The three large mills operated by Shaw, Essey & Co. have been fitted with electric lights.

Noblesville, Ind.—The electric light plant has been completed, and the city is lighted by several lights.

Roseburgh, Ore.—It is expected that the electric lighting system will be ready for operation this week.

Homer, Ill.—It is stated that there is a decided movement in favor of putting in an electric light plant.

Columbia, Pa.—The Columbia Electric Light and Power Company is wiring for its incandescent system.

Le Roy, N. Y.—A new 125 h. p. boiler is being put in the electric lighting plant of the Le Roy Gas Company.

Arkadelphia, Ark.—It is expected that the electric light plant will be in operation by the last of the month.

Salem, Mass.—Castle Hill and South Salem are to be lighted by 211 incandescent lights, in place of gas lights.

Colchester, Ill.—A company has been organized, with a capital stock of $6,000, to erect an electric light plant.

Sherman, Tex.—An electric light plant will be put into the bag factory of the Sherman Seamless Bag Company.

Kensington, Ill.—It is reported that the People's Light and Power Company will erect an electric lighting plant.

Thompsonville, Conn.—The town will be lighted by electric lights, the power station having already been located.

Kirksville, Mo.—The proposition to issue bonds for $38,000 to build an electric light plant, etc., will be voted upon Nov. 3.

Wellsville, N. Y.—The Citizens' Electric Light Company is being organized. John McEwen is identified with the new company.

Portland, Me.—The contract for city lighting for the fiscal year has been let to the Consolidated Electric Light Company for $83,000.

Washington, Pa.—Two 100-h. p. engines, each costing $2,000 have been placed in position at the power house of the new electric light plant.

Minonk, Ill.—The Minonk Electric Light and Power Company is putting in several new lights in business houses. The city now has 71 lights.

Vergennes, Vt.—At a meeting held recently to consider the electric lighting question, it was decided by a vote of 81 to 58 to erect a plant of 20 arc light capacity.

Woodstock, Ont.—At a recent meeting of the Town Council the Edison Electric Company made application asking a franchise to put up poles, etc., to operate an incandescent system.

Edgerton, Wis.—The City Council has granted a franchise to M. Pelton, W. T. Pomeroy, F. W. Coon and others to erect an electric light plant, which it is expected will be in operation by Dec. 1.

Norwalk, O.—The Incandescent Light and Power Company has accepted the contract for street lighting for five years, the city to pay $58 per lamp for one o'clock lighting and $62.50 for all night lighting.

Leavenworth, Kan.—It is stated that sufficient stock has been subscribed to insure the success of the merchants' electric light project, and that bids for the construction of the plant will be advertised for at once.

Cleveland, O.—The electric roads in the city are prepared to do electric lighting, and are negotiating with the city for illuminating the 50 miles of road through which their lines run, as well as adjacent thoroughfares.

Waterville, Me.—The company of which A. F. Gerald is president, H. D. Bates treasurer, and H. W. Heath secretary, it is stated, is ready to begin work. It will conduct the electric systems of Waterville and Fairfield and furnish power for the city electric light plant.

St. Cloud, Minn.—The Edison Columbia Company, of St. Paul, has been awarded the contract for furnishing the electric light plant for the State Reformatory, at a cost of $1,825. The contract calls for a 250-h. p dynamo, to furnish 170 lights of 16 c. p., and 128 lights of 10 c. p. The work is to be completed by Nov. 15.

Charlestown, W. Va.—The Citizens' Electric Company, recently organized, expects to have its plant in operation in 90 days. The officers of the company are: B. D. Gibson, president: Gustav Brown, vice-president, and William Campbell, secretary and treasurer. The electrical and mechanical details of the plant are under the direction of Mr. Chas. C. Caldwell, the electrician of the company. This company was previously reported as having been organized to erect a plant in Charleston, W. Va.

Chanute, Kan.—Geo. W. Alcock and John A. Cross, Council Committee on Electric Lighting, appointed to investigate systems of electric lighting, with a view to the erection of a city plant, has made its report to the Mayor and Common Council, recommending, among other matters, that the Franklin Electric Company, of Kansas City, be employed to make a survey of the city and draw plans and specifications for the plant, also that the city adopt some system at once.

Train Lighting.—One of the express trains running between Berlin and Frankfort has been fitted with the electric light. Each coach has two distinct storage batteries, and the lamps are on two distinct circuits, so that in case of accident to one circuit, or on changing the batteries, the carriage shall not be left entirely without light. The storage cells are especially designed to stand rough handling, and have a capacity of 200 ampère-hours. Each battery supplies current to four 8-c. p. lamps for the compartments, and to one 5-c. p. lamp in the lavatory. The batteries, which weigh 6 cwt. each, are placed in boxes underneath the carriage floor, and can be taken out and replaced very rapidly.

Alameda, Cal.—The Oakland Gas, Light and Heat Company presented a communication to the City Council recently, with an offer to take charge of the city's electric light plant. The company offered to pay $150 per month rental for the plant and to assume the obligation to pay the principal of the bonds issued for its purchase and now remaining unpaid, amounting to nearly $38,000 and having eighteen years to run. The city is to pay the interest, however, and the further sum of $750 per month for the maintenance of the ninety-three lights now burning, and 35 cents per lamp per night for each additional lamp, the plant to become the property of the company at the end of eighteen years, but the title to remain in the city until the lapse of that time. The proposition was referred to the committee on lights.

Savannah, Ga.—In the lighting of the streets of Savannah and its places of business electricity has gradually driven out gas, and there are now over 3,000 incandescent lights in use, and 400 arc lights, 250 of the latter illuminating the city's thoroughfares. Mr. S. P. Hamilton, the president of the Brush Electric Light and Power Company, of Savannah, states that the company started business nine years ago with one arc dynamo and one incandescent dynamo. The business has had a steady growth and the company's plant now includes eight arc dynamos and six incandescent dynamos, all fully taxed. A power generator has also been put in with a capacity of 125 horse power. Seven boilers and seven engines are required to drive this immense plant. The company furnishes motive power to every printing house in the city except one. Only one elevator is now run by electricity, but in a short time it is believed that all in the city will adopt this power. Small industrial establishments are also considering the advisability of dispensing with steam power in favor of electricity, and great advances in this direction may be expected during the present year.

Electric Light in St. Henri.—A somewhat important movement, which may have an influence on the price of furnishing electric light to municipalities generally, has been made by that of St. Henri, one of the adjoining municipalities of Montreal. The town had been furnished with street electric light up to September last at $100 per light per annum. Since then the Royal Electric Company has been doing the work, but charging $140 per light. A short time since the municipality refused to continue to take the light at what it considered an exorbitant price, and, in consequence, the town found itself in the dark, the company having rather summarily, it is alleged, "cut off the circuit." But meantime the St. Henri council had not been idle, having been in active correspondence with an electric company in the States, which finally agreed not only to furnish the light at once by means of a temporary apparatus, and at the reduced rates, but to forthwith construct works and erect buildings in the town, which would supply light to Cote, St. Paul and another municipality as well. The agreement was signed between the Council and the company recently, by which the former exempts the company's buildings from taxation for 10 years, the term for which the light is to be supplied. St. Henri will thus have an electrical establishment, the buildings alone costing about $18,000, and perhaps will also, by increasing competition, give the people generally cheaper electric light.

THE ELECTRIC RAILWAY.

Bridgewater, Mass.—The question of building an electric road to Brockton is being agitated.

San Jose, Cal.—Jacob Rich has been granted the right to construct, maintain and operate an electric railway in the city of San Jose.

Detroit, Mich.—W. H. Stevens, C. W. Volgt and others, have made application to the Common Council for a franchise to build a street railway to be operated on certain streets of the city.

Windsor, Ont.—The equipment of the Windsor and Sandwich Street Railway, recently completed by the Westinghouse company, consists of six closed and four open cars. Two of the closed cars have double motors and the others single.

Windsor, Ont.—W. C. Turner, manager of the Windsor, Sandwich & Amhertsburg Railway Company, is interested in the Citizens' Electric Light Company, which is to furnish electric lights for Windsor, Walkerville and Sandwich. The new company is to be capitalized for $50,000, of which $10,000 will be paid in.

PERSONALS.

Mr. J. W. Beane, it is understood, has resigned as secretary of the National Electric Light Association, to take effect Nov. 15.

Mr. Wm. R. McKenzie, formerly with the electric light company, Middletown, N. Y., has taken charge of the electric light plant being erected at Marion, O., acting as superintendent of construction.

Mr. C. F. Cole, for a number of years with the Thomson-Houston Company, of Philadelphia, has recently taken charge of the La Roche Electric Works, of Philadelphia, his position being that of assistant general manager. He reports that his company is doing a most satisfactory business, running night and day to keep up with orders.

Mr. Edward H. Chapin, who will on Nov. 1 resign his position with the *Street Railway Journal*, has made a host of friends throughout the country by his gentlemanly manner and untiring devotion to the interests of his many customers. Mr. Chapin's connection with the journal has been a remarkable success, and his retirement is sincerely regretted by the management. He, however, has made arrangements to go into commercial business in Rochester, N. Y., and there is no doubt of his success if hard work and strict business principles are any criterion.

Mr. Herbert Laws Webb has accepted the position of editor of our Chicago contemporary, *Electricity*. Mr. Webb is well known to the electrical fraternity through his connection with the Metropolitan Telephone and Telegraph Company, of New York City, and through the numerous contributions which he has made to electrical journals and to such periodicals as *Scribner's Monthly* and *Harper's Weekly*. As a nephew of Mr. W. H. Preece his name is also well known in England. It is to be hoped that Mr. Dickerson's enforced retirement from the editorship of the paper, due to a severe attack of typhoid fever, may not seriously interfere with his plans for future work in connection with electrical journalism.

LEGAL NOTE.

Suit has been entered by Charles A. Terry, attorney for the Westinghouse Electric Manufacturing Company, in the United States courts in behalf of that company against the Pittsburgh and Birmingham Traction Company for the infringment on its patent covering a new device on electric motors rendering them both noiseless and durable. The invention was made and patented on Dec. 9, 1890, by Albert Smith, and was assigned by him to the Westinghouse company. It is alleged that the Westinghouse company has put on several hundred of these motors, and they have been successful in their operation from the first. The success of the motor made them so desirable that nearly all of the other companies engaged in the same business have, it is alleged, taken the risk of infringing on the patent. The present suit is a most important one, and is brought with a view of making it a test case.

EDUCATIONAL NOTE.

The Michigan Mining School, of Houghton, Mich., in its catalogue for 1891, has in its curriculum a course in electrical engineering under Prof. Edgar Kidwell, M. E., as instructor. A preparatory course is given, supplemented in the second year by instruction in electrical instruments and measurements, electrical engineering being taken up in the third year as a finishing course. The Michigan Mining School is a prominent institution and its departments of instruction offer the best of advantages for training in mechanical, mining and electrical engineering. Its faculty is composed of educators of high standing and its graduates rank with those of any similar institution in the country.

Industrial and Trade Notes.

The Rousseau Electrical Works, Railroad avenue, near 138th street, New York City, manufacturers of burglar and fire alarms, annunciators, electric gas lighting apparatus, etc., are about to publish a new illustrated catalogue of their many specialties. Mr. Rousseau will also shortly place upon the market some new specialties which will be of great interest to the trade.

A New Name.—The New York publication known as *Office* has changed its name and is now known as *Business*. The first number under the new régime is the October issue. This publication is one that should be in every business man's office, as it contain as a great deal of information of value to every man who wishes to conduct his business in accordance with the best methods.

The Aluminium Carbon Company, of Buffalo, N. Y. which only started in business this summer, is now running its factory night and day, being compelled to do so by the large amount of orders received. As the daily capacity of the plant is 60,000 carbons, their success in so short a time is something phenomenal, and goes to prove that the goods manufactured by this company are unusually good and all claimed for them.

The Steamloop is the title of a pamphlet just issued by Mr. Walter C. Kerr, of the firm of Westinghouse, Church, Kerr & Co. The pamphlet contains a reprint from the journal of the Franklin Institute of October of a lecture delivered before the Institute last February by Mr. Kerr. The paper contains a very complete and clear description of the steamloop, and a number of illustrations aid in understanding the principle of its operation.

Armington & Sims Engines.—The Pond Engineering Company, of St. Louis, reports an excellent demand from its various offices for Armington & Sims engines for driving dynamos. Engines are now being furnished for the State Insane Asylum, San Antonio, Tex.; Pacific Branch National Soldiers' Home, Santa Monica, Cal.; Edison General Electric Company, for Traverse City Asylum, Traverse City, Mich.; Waterloo, Ill., Electric Light Company; Provident Life Assurance building, Waco, Tex.

M. G. W. Caudle has just returned from a trip through the South and East in the interests of the Triumph Compound Engine Company, of Cincinnati, O. He reports business so good that it will be necessary for the company to increase its manufacturing facilities in order to complete the orders now on hand at the time specified. This company has arranged to place upon the market a combination plant consisting of the Triumph engine and a Billberg dynamo connected directly to its shaft, no fly wheel being used.

The "C. & C." Electric Motor Company, of New York, has recently installed a 75-light dynamo for the Snow Steam Pump Company, Buffalo, N. Y.; one 175-light dynamo for the Cogdon Brake Shoe Company, Fifty-ninth street, Chicago, Ill.; one 500-light dynamo in the Mitchell Flats, Cincinnati, O.; two 250-light dynamos in the St. Nicholas Hotel, Cincinnati, O.; one 125-light dynamo for Mock Berman & Co., 119 West Third street, Cincinnati, O.; one 150-light dynamo for W. J. Morgan & Co., Cleveland, O.; one 100-light dynamo for the Bethel Association, Cleveland, O.; one 60-light dynamo for the Northern Ohio Asylum for the Insane, Cleveland, O.; one 100-light dynamo for the steamer "Royal," Evansville, Ind.; one 40-light dynamo for the Upton Glue Company, Gardiner, Me.; one 40-light dynamo for the Boston Paper Company, Hallowell, Mass.; one 200-light dynamo for the iron foundry of T. Shriver & Co., 333 East Fifty-sixth street, New York; one 150-light dynamo for Messrs. Weser Bros., piano manufacturers, 524 West Twenty-third street, New York; one 40-light dynamo for the Upton Glue Company, Peabody, Mass.; one 150-light dynamo for Jordan & Goodrich Shoe Company, Ravenna, O.; one 500-light dynamo for lighting the offices of the Brush Electric Light Company, Rochester, N. Y.; one 40-light dynamo for the Upton Felting Mills, Salem, Mass.

Business Notice.

The price of the No. 1 universal milling machine without over-hanging arm, made by the Brown & Sharpe Manufacturing Company, Providence, R. I., is $480. Price of the machine with overhanging arm, $495. Previous prices, $550 and $585.

Owing to the length of the Street Railway Convention proceedings the Patent Department is omitted this week.